SIXTH EDITION.

SIGHT TESTING

FOR THE

GENERAL PRACTITIONER.

Price 2/6 nett.

BY

F. DAVIDSON.

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TWELFTH THOUSAND. SIXTH EDITION.

SIGHT TESTING

FOR THE

GENERAL PRACTITIONER.

A manual by which he can acquire the knowledge necessary to determine all errors of refraction, and to prescribe spectacles.

BY

F. DAVIDSON.

PRICE 2/6 NETT.

LONDON:
F. DAVIDSON, 29, GT. PORTLAND STREET, W.

1915.

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Introduction to the Sixth Edition.

NOTE.—This manual is written for the doctor only and in order to be able to control its sale I publish it myself. A study of it should enable one to understand how easily the work may be done.—F. DAVIDSON.

* * *

TO THE MEDICAL PROFESSION:—

I think it will be admitted that, in no branch of professional work, is more decided competition encountered than in general medical practice. If this be so it must be surely worth while to consider if, by any legitimate means, it is possible to overcome the ill effects of the said competition. The work that one has to do in general practice is but badly remunerated and at the end of the year there is often not much that one can congratulate one's self upon. New competitors are continually arising and with these the doctor has to contend.

It may perhaps be known to you that for the past 20 years I have been advising the general practitioner to include in his practice REFRACTION WORK and the supply of spectacles to his patients direct; I undertake to thoroughly teach him a simple sound method of both subjective and objective testing. My success in this direction has been great and I am justified, therefore, in suggesting that the matter is worth consideration by all who do not do this work. I will not dwell upon the advantage gained in dealing with a case where the refractive condition is known. It is well understood that very many of the troubles a doctor is called upon to treat may arise wholly or in part from the ocular conditions. If therefore an examination of the eyes formed the *first* stage in the routine of general diagnosis, it is certain that in great numbers of cases the result would justify advising the use of glasses.

To the three principal objections advanced against the idea of doing refraction work, namely; 1, "The time it occupies;" 2, "The difficulty of obtaining payable fees;" and 3, "Patients won't come to me for spectacles;" I would respectfully reply as follows, and my reply is based upon 20 years' experience of the work done by medical men in this direction:—

Objection No. 1.—The simple system taught by me will enable one to arrive at his results in from 5 to 15 minutes in the majority of cases. Even though one cannot give normal vision, this fact becomes known very quickly and so no time is lost. This would be a case which no doubt, it would be deemed advisable to send to a specialist.

Objection No. 2.—By providing glasses as well as prescribing them it is possible to make the work very remunerative, as the low prices at which they are supplied to doctors permits this if the patients are charged only the *ordinary* retail prices.

Objection No. 3.—Doctors can, as it were, create their work by doing as previously suggested, that is, by making the examination of the eyes their *first* care. It would soon become known that he did this work and my experience is that patients *prefer* their medical man to do this, and to see that their spectacles are right, to going to a shop to have it done.

As a proof of this I would mention that my business has been built up almost entirely upon the spectacle work done by medical men, as I do not cater for the public at all directly.

Even after the course of instruction has been gone through, my personal supervision of all prescriptions is assured to avoid possible errors, and where a puzzling case arises, my assistance often enables one to overcome a difficulty. Numbers of medical men will be pleased to testify to the soundness of the instruction given and to the results of the work.

Fee for a full private course of instruction at Great Portland Street, Three Guineas.

REFRACTION CLASSES

are held by Mr. Davidson in various provincial centres from time to time at a fee of Three Guineas.

Classes have already been held at LIVERPOOL, MANCHESTER, BRADFORD, LEEDS, SHEFFIELD and BIRMINGHAM.

The following are a few of the Testimonials received:

Leeds.

"The instruction you gave has enabled me to take up 'refraction work' with confidence. I can confidently recommend my professional brethren to take advantage of your thoroughly practical knowledge of the subject."

Leeds.

"I have much pleasure in testifying to the value of the classes you hold on 'Sight Testing.' The amount of information you manage to convey in the time at your disposal is wonderful; your methods are clear and painstaking, and I only wish I had been offered this facility earlier in my career."

Sheffield.

"I consider your method is simple, scientific and accurate, and if your system is carefully followed, any appreciable error must be an impossibility. I shall be glad to recommend your course of instruction to any medical man."

Edgbaston.

"I have much pleasure in speaking highly of the thoroughness and lucidity with which Mr. Davidson instructs his pupils and shall be pleased to act as a reference."

Manchester.

"I consider Mr. Davidson is a born teacher. His methods of instructing a class are wonderfully effective. Each individual seems to feel he is getting personal attention."

Liverpool.

"I am sure you have succeeded in making a very complicated subject as simple and clear as it is possible to make it."

SIGHT TESTING.

CHAPTER I.

Defective Sight is simply a deficiency between the sight one has, and that which one *ought* to have. It is necessary therefore to have a standard for the normal acuteness of vision by which we can measure the acuteness of the sight being tested, and this standard is sufficiently shown in my "Improved Complete Sight Test" Card.

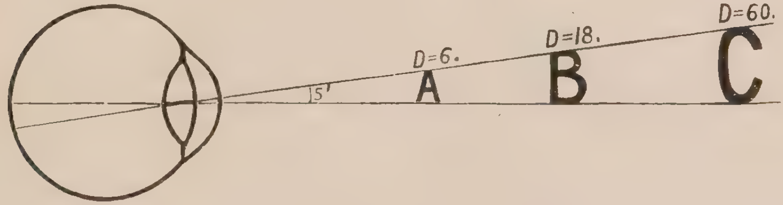


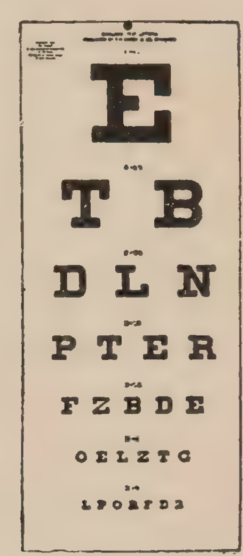
Fig. 1.

Acuteness of Vision.

The smallest visual angle for clear vision being 5′, letters which at given distances subtend this angle have been adopted as tests for the acuteness of vision. All test cards therefore have a series of letters of different sizes and arranged for various distances printed upon them. "Every letter is so made that, when at its proper distance, each part is separated from the other parts by an interval equal to not less than the arc subtending an angle of 1° at the nodal point, while the letter subtends an angle of 5 (*Hartridge*)." Fig. 1.

Test Types.

The figures at the foot of each series of letters denote the distance at which the normal eye can read them. When the patient can only see at six metres the letters which he ought to see at *sixty*, vision is only equal to $\frac{6}{60}$; and it is noted thus: $V = \frac{6}{60.}$ If he can read those marked 12 M.—$V = \frac{6}{12.}$ Normal sight is expressed thus :—$V = \frac{6}{6.}$


E
T B
D L N
P T E R
F Z B D E
O E L Z T C

Specimen Test Card.

When we know what size types the normal eye can read at a certain distance, it is easy to discover what difference (if any) exists in the eye being tested, and it is this difference which has to be corrected.

Normal Sight.

It is impossible to improve the perfect, so if one can read the letters at the required distance and vision is made worse with *any* convex lens, spherical or cylindrical, the sight may be considered normal ; subject to the test for muscular equilibrium not disclosing marked esophoria. In such a case there may be *latent* hypermetropia.

LENSES.

CHAPTER II.

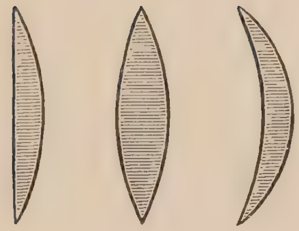


Fig. 2.

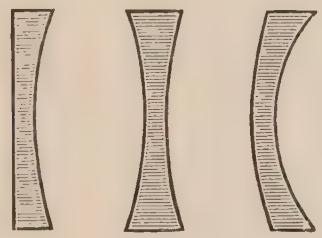


Fig. 3.

Spherical Convex: Spherical Concave:

(Plano, Double or Periscopic.)

Cylindrical Convex: Cylindrical Concave.

The above are the different forms of lenses in use either alone or in combination.

WHAT is a spherical lens? The answer is "a section of a sphere." In the diagram (Fig. 4) the dotted lines represent the outlines of a sphere, and if a section be made from A to B the black segment will be recognised

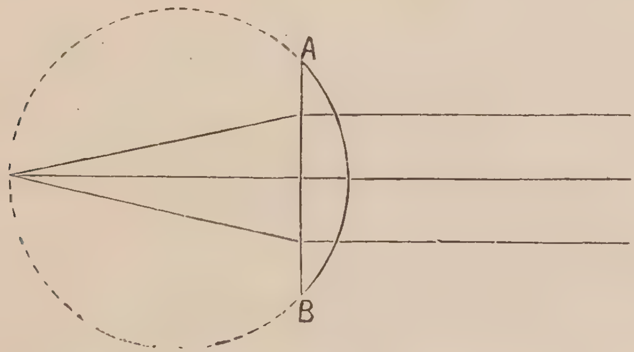


Fig. 4.—Showing the focal length of a plano-convex lens to be equal to twice the length of its radius.

as a representation of a plano-convex spherical lens. Rays of light passing through this lens will be *converged* and brought to a focus.

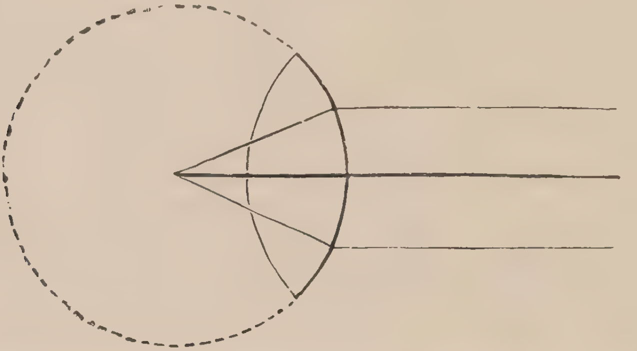


Fig. 5—Showing the focal length of a bi-convex lens to be equal to its radius.

Spherical Convex Lenses.

Spherical convex lenses are thickest in the centre, thin at the edges. They *converge* rays of light so that they meet at what is called their focus (bringing them to a focal point). They *magnify*—an object looked at through one appears nearer, and if the lens is moved appears to move in an *opposite* direction. From the centre of the lens the light is *equally* refracted as it strikes the bent surface, while the light which passes through the centre emerges unrefracted on the other side.

The prefix + (plus) signifies convex.

Concave lenses are thinnest in the centre, thick at the edges. They make rays of light *divergent*, so that they never meet. They *minify*—an object seen through one appears further away, and if the lens be moved, appears to move in the same direction.

The prefix — (minus) signifies concave.

Cylindrical Lenses.

What is a cylindrical lens? Conforming to my definition of a spherical lens, I would answer, "the section of a cylinder" as illustrated in Fig. 6, a plano-convex cylinder. A piece of lead pencil split through its length would illustrate it practically.

To illustrate a *concave* cylindrical lens take a square rod with a hole bored right through, split this down its length and the result is a pair of concave cylinders.

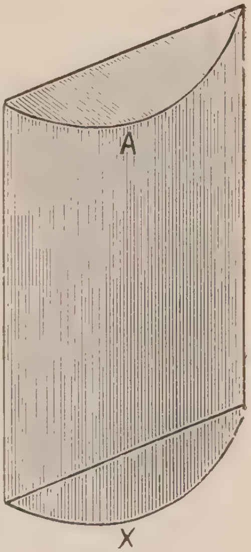


Fig. 6.

Hold a split pencil in your hand and you will observe that *along its length there is no curve.* The curved portion is at *right angles to its length.* There is an imaginary line from which the curve begins and this is called the "axis," so it will be apparent that if you now imagine that the section of the pencil is made of glass you will recognise that if you hold it vertically the light which will pass through it *perpendicular* to its length, *i.e*, the axis, is not refracted at all. It enters in a straight line and emerges in a straight line. It is only the light which strikes the surface at right angles to the axis which *is* refracted or bent *towards* the axis: *but always in a line:* in this instance a vertical line.

Analysing or Focussing Lenses.

The power of any lens can be found by neutralizing the apparent movement of the object looked at through it; for instance: looking at any object through a convex lens that is being slowly moved, the object seems to move in the *opposite* direction; looking through a concave lens, the object appears to move in the same direction, so that the movement seen through the convex can be counteracted by placing a concave over it, and the lens that will perfectly neutralize any movement must be of the same opposite power as the one it corrects, thus: a 1.D concave will neutralize a 1.D convex; a 4.D concave neutralizes 4.D convex, and so on.

The most accurate way to measure a lens is to *neutralize* it with opposite lenses of known powers. A lens measure may be employed and the focus obtained which will be perhaps correct in the lower numbers and very approximately so in the higher, but the *safer* way is to neutralize.

Neutralize with Sphericals.

Neutralization is best done with *Sphericals* although a cylinder or sphero-cylinder is the lens in question. For the latter first find the spherical lens which neutralizes in one meridian and then do likewise for the other: the *difference* in the strength of the two sphericals denotes the power of the cylinder while the *weaker* of the two sphericals is the spherical part of the combination.

Prove with a Cylinder.

The neutralization is then *proved* by means of the *actual* cylinder and spherical.

Testing a simple Cylinder.

To test a simple cylinder—the diameter of the axis having of course no focus—the spherical lens which is necessary to neutralise the movement in the opposite meridian should be found, and as before the *proof* is furnished by the cylinder.

Spherical.

A spherical lens is recognised by the apparent movement seen through it being *equal*, no matter in what meridian it is moved.

Simple Cylinder.

If it is a simple cylinder, *no* movement at all will be noticed in one certain meridian—corresponding to its axis.

Sphero-Cyl.

If it is a sphero-cylinder the movement will be *more pronounced* in one meridian than another.

Prism.

In a prism of *low* degree ($\frac{1}{2}$°) *no* movement will be detected *except* it be *revolved* rather sharply, or a straight line be looked at. In the latter case the line will appear to be broken. In the higher powers its *shape* will betray its nature.

In all lenses which are combinations of either spherical and prism, cylinder and prism, or spherical, cylinder and prism, the spherical and cylindrical elements must be discovered first and the degree of the prism can then be ascertained by holding the lens and its neutralizing refractive element together, perfectly centred, and looking through them at a prism scale made for the purpose.

Numbering Lenses.

Lenses are numbered according to their power. The Dioptric system of measurement, which is now generally used, takes a lens of One Dioptric as its standard ; this lens has a focus of a metre (that is about 40 inches). All other lenses are either multiples or fractions of 1 D (Dioptric).

The following scale shows their focal measurements :—

LENS SCALE.

Dioptric	Focus at	Dioptric	Focus at
0.25	160 ins.	5.0	8 ins.
0.50	80 ,,	5.5	7 ,,
0.75	53 ,,	6.0	6½ ,,
1.0	40 ,,	6.5	6 ,,
1.25	36 ,,	7.0	5½ ,,
1.50	30 ,,	8.0	5 ,,
1.75	24 ,,	9.0	4½ ,,
2.0	20 ,,	10.0	4 ,,
2.25	18 ,,	11.0	3½ ,,
2.50	16 ,,	12.0	3¼ ,,
2.75	14 ,,	13.0	3 ,,
3.0	13 ,,	14.0	2¾ ,,
3.25	12 ,,	15.0	2⅝ ,,
3.5	11 ,,	16.0	2½ ,,
4.0	10 ,,	18.0	2¼ ,,
4.5	9 ,,	20.0	2 ,,

The point at which light can be brought to a focus through a convex lens is called its "principal focus" and the distance this is from the lens is its focal measurement.

To convert inches into diopters, or *vice versa*, divide 40 by either, to find the other. Thus a 10″ lens is one of 4 diopters, and a 4.D lens will bring light to a focus at 10 inches.

CHAPTER III.

DEFECTIVE SIGHT.

THE different conditions of defective sight are known as Hypermetropia (Far Sight), Myopia (Near Sight), Presbyopia (Old Sight), Astigmatism (Peculiar Sight), and Asthenopia (Weak Sight), and we must confine attention first to finding out which of these defects the patient is troubled with.

Physiology of Vision.

The globe, or ball of the eye is a spherical body, the cavity of which is filled with aqueous and vitreous humours which, together with the crystalline lens and the cornea, form what is known as the refractive media or means of refraction. Light proceeding from the object looked at, enters through the pupil, and by means of the refractive media is brought to a focus on the retina. The retina receives a picture of the object, the visual impression is by means of the optic nerve conveyed to the brain, and so the act of seeing is completed. This can only be done providing the axial length of the eyeball and the focal length are the same.

Let us assume, therefore, for the sake of illustration, the axial length of the eyeball to be the distance between the pupil and the retina or from front to back, and the focal length to be the distance between the top and bottom as in fig. 10.

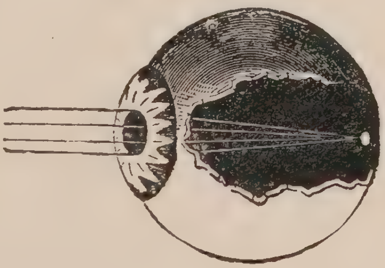


Fig. 10.

CHAPTER IV.

HYPERMETROPIA.

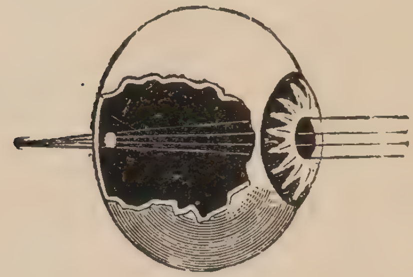


Fig. 11.

This defect depends for its existence upon a shortening of the optical axis—the axial length is less than the focal length—and the retina is situated too far forward. Therefore, rays of light would, if possible pass through the retina, and come to a focus beyond it. This not being possible, the result is a diffused image and the object looked at is not clearly visible. Fig. 11.

Effort of Accommodation in Hypermetropia.

It is on account of the strain placed upon the muscles of accommodation in hypermetropia, the effort to bring the rays of light to an earlier focus on the retina, which is the cause of the fatigue, pain, headache, and speedy dimness of vision which attend the employment of the eyes over any matters requiring close application. These therefore are among the most common symptoms of hypermetropia.

I nearly always advise the *constant* use of glasses in Hypermetropia, except where there is but a small amount of this defect in elderly people. The question is frequently asked by patients so advised "*why* must I wear glasses always when I can see well enough at a distance?" The reply is that while one whose vision is normal can see at a distance without effort, without having to use the ciliary muscles, the Hypermetrope *must* use the said muscle and so it is practically always tired. The constant use of the glasses does away with the necessity of calling upon the ciliary muscles for any effort *except* for near work and the nett result is that the eyes are not fatigued *before* they begin upon close work. Where different glasses are needed for far and near work, as in the case of hypermetropes who are also presbyopes, it may be truly argued that *one pair helps the other;* and so the patient obtains the best possible result from the use of spectacles.

Rationale of Correction.

It is obvious that what is necessary in order to relieve the eyes from this intolerable strain is something that will bring light to an *earlier* focus. This is done by placing in front of the eye a *convex* lens, which by converging the rays somewhat *before* they enter the eye, enables them to come to a focus upon the retina. In hypermetropes the convergence is in *excess* of the accommodation.

Squint.

Squint (convergent) is another of the general symptoms of hypermetropes in children. It is generally constant. It is called "alternating" squint when the squint is noticeable first in one eye and then in the other. It is called "fixed" when the squint is permanent in one eye.

CHAPTER V.

MYOPIA.

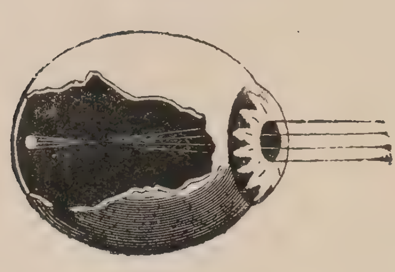


Fig. 12.

Convergent Effort in Myopia.

In this defect the axial length of the eyeball is *greater* than the focal length, and the retina is situated too far back; consequently rays of light are brought to a focus *before they reach it*, overcross each other, and in this state come to the retina, and only objects comparatively near can be seen clearly.

The myope is obliged to hold his book closer to his eyes than he ought. In order to see near objects the eyes must converge, and it is this constant convergent effort in myopia, which, if not counteracted, causes the defect *to provide for its own increase*, and is the cause of progressive myopia. In this there is always the danger of ultimate blindness.

When myopia increases even after adult life is reached, when in spite of every precaution the defect goes from bad to worse until perhaps finally all useful vision is lost, the term malignant or progressive myopia is used. In such cases even if the myopia remains stationary, atrophy, hæmorrhage, opacities and retinal detachment still threaten the eye.

Attention to the general health, avoidance of indoor occupations that require constant and close use of the eyes, preference for outdoor work and sometimes a total abstinence from reading are important points in the treatment.

The symptoms of progressive myopia are frequently a simple desire for stronger and yet stronger glasses without any other inconvenience.

Here we have to deal with the *opposite* conditions as obtained in hypermetropia, and by placing a concave lens in front of the eye the rays are made to *diverge* before entering—as if they came from a greater distance—so that they come to a *later* focus.

CHAPTER VI.

ACCOMMODATION.

The power of accommodation is that power we possess of unconsciously altering the focal conditions of the eye. This function is performed by means of the crystalline lens and the ciliary muscle. This lens has the same effect upon light as an ordinary bi-convex lens. We know that the stronger the convex lens is, the sharper the curve is, and the nearer must be its focus. In looking at objects at a distance the eye may be said to be at rest, and the focal conditions are adapted to this. In order to see at a near point, these conditions must be altered. By means of the ciliary muscle the crystalline lens is enabled to assume a greater convexity, and, therefore, near objects are rendered visible.

The *exercise* of accommodation enables an eye to see objects clearly between its *far point* which, in an emmetropic eye is at infinity, and its *near point*, which in the young is within a fèw inches from the eye.

Accommodation has so far only been considered as taking place in one eye, but both eyes unite in associated movements, whereby binocular vision is obtained, *i.e.*, while the power of accommodation enables a near as well as a distant object to be seen, *the power of convergence* enables the eyes to blend as it were the images formed upon the retina of each eye into *one*.

It will be readily understood that to get comfortable vision, the eyes must accommodate to the same extent as they converge and *vice versa*. Generally speaking, any deviation from this causes ASTHENOPIA.

CHAPTER VII.

PRESBYOPIA

(Old Sight).

In the chapter on "Accommodation" we have understood that in order to see *near* objects clearly the crystalline lens assumes a greater convexity. This lens, which is a transparent capsule, must of necessity be and is of an elastic nature in youth. As age increases it gradually loses its elasticity. Naturally, as it loses its elasticity, it loses its power of increasing its convexity, and the consequence is that it cannot become sufficiently convex to enable objects to be seen as near as formerly. It is this gradual loss of the power of accommodation and consequent recession of the *near* point of vision, which constitutes the physiological change which is known as Presbyopia. It becomes manifest *only after passing 40 years of age*, *except in hypermetropes*, as in such cases part of the range of accommodation at its far end is absorbed in neutralizing the refractive error.

Symptoms of Presbyopia.

The first symptoms of this change are a gradually increasing sensation of effort and fatigue after doing fine work, or looking at small objects, a complaint that *more light* is necessary than used to be the case. This feeling may be termed *Presbyopic Asthenopia*, and the sense of discomfort soon compels the suspension of the occupation.

Correction.

By means of a convex lens placed in front of the eye of sufficient strength to compensate for the loss of accommodative power within the eye, near objects can be rendered as clearly visible as they were previously.

The following is an approximate scale of the power of glasses required to correct Presbyopia in emmetropic eyes:

Age	45.	50.	55.	60.	65.	70.	75.
Dioptres	.50	1.0	1.75	2.50	3.5	4.5	5.5

I am aware that the mathematical correction is a little more than this, but my experience shows the above scale to be more closely allied to *comfort.* When hypermetropes become presbyopic the above *addition* to the hypermetropic correction should be given for near work—subject of course to *proving* with the trial lenses.

The *best* correction in cases of simple presbyopia is a lens only adequate to give distinct vision, without conscious magnification of the object: and to use them *at first* only when there is insufficient illumination for close work. If selected in this way, they will frequently last a long time without a change being required.

Presbyopia (Old Sight) with Hypermetropia (Far Sight).

A HYPERMETROPE IS CONSCIOUS OF PRESBYOPIA AT AN EARLIER AGE THAN AN EMMETROPE.

If a person who is hypermetropic be over 40 years of age, he will be *presbyopic also*, and the lenses which correct the distance sight are not strong enough for *near* work. Test these cases with the lenses that correct the hypermetropia, and find what additional lens is necessary to enable small print to be read near enough. These cases require the lenses that correct *only* the hypermetropia to be worn *constantly*, and those which enable him to see near enough, to be used for reading and writing with.

Presbyopia with Myopia.

A MYOPE OF LOW DEGREE IS CONSCIOUS OF PRESBYOPIA AT A LATER AGE THAN AN EMMETROPE: if, however, the myopia is more than 3.D NEVER.

The governing conditions in these cases is the amount of MYOPIA existing: not the amount of presbyopia.

The *recession of the near point* of vision constitutes the presbyopic change, and as the *far* point of an emmetrope is at *infinity*, it follows that the *near* point can recede to such a distance that it is lost altogether as regards seeing print at an ordinary reading distance.

The *far point of a myope* is at a certain fixed distance —dependent upon the amount of myopia present. It is obvious that if the far point is but a short distance from the eyes the *full recession* of the near point cannot take it *beyond* the far point.

From this explanation it will be readily understood that a myope may never require a convex glass for reading. The far point of a myope is, as already mentioned, *governed by the amount of myopia.*

To FIND THE MYOPIC FAR POINT ascertain *how far* the patient is able to read the small print on an ordinary reading type card.

The distance in centimetres denotes the dioptric power of the lens required for distance and at the same time records the *amount of myopia*. It is only necessary to remember that a lens of 1 dioptre focusses at 100 centimetres (40″). If therefore small print cannot be seen farther off than say 50 c/m. it is arrived at by dividing 100 by 50 The result, 2, is the dioptric power of the lens required to *correct the myopia.*

If 10 c/m is the far point, then 100 ÷ 10 = 10. The myopic correction would be —10 D.

From the foregoing it will be understood that a myope of 3.D would *never* require a convex glass for reading, *no matter what his age might be*, as his far *point* for reading being at about 33 c/m his *near* point can never get beyond this. If however *less* myopia than this exists he *may* require a convex glass for reading at some period of his life, while still needing concave lenses for distance.

THE PRINCIPLE INVOLVED HERE is most important and *must be grasped* as a preliminary to correct work when dealing with cases involving myopic or mixed astigmatism and presbyopia, which will be discussed later on.

CHAPTER VIII.

ASTIGMATISM.

In hypermetropia and myopia the conditions have been considered as applying to an eye in which the refracting surfaces were truly spherical. This is not always the case, and although a slight departure from true sphericity may be almost left out of consideration, any marked departure from it influences to a considerable extent the acuteness of vision, and the result is that peculiar form of anomaly of refraction which is known as astigmatism.

The refraction of an astigmatic eye, is, therefore, not the same in its different meridians. It is strongest in the meridian with the strongest curvature, and most feeble in that where the curvature is least. The unequal shape of the *cornea* is more generally responsible for astigmatism than any other part of the dioptric apparatus of the eye. The rays of light which pass through the *most* convex part of it come to an earlier focus than the others.

Different kinds of Astigmatism.

Astigmatism may assume one of five different kinds, namely: Simple Hypermetropic, Compound Hypermetropic, Simple Myopic, Compound Myopic, and Mixed.

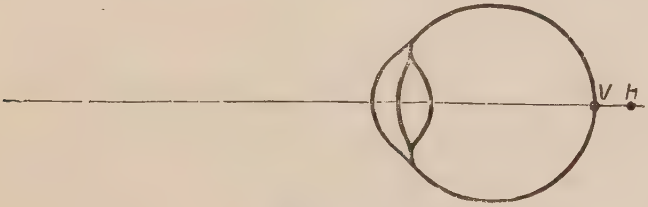


Fig. 13.

Simple Hypermetropic Astigmatism.

This is the condition in which one set of rays V is brought to a focus *on* the retina, while another H *does not come to a focus at all* as in fig. 13.

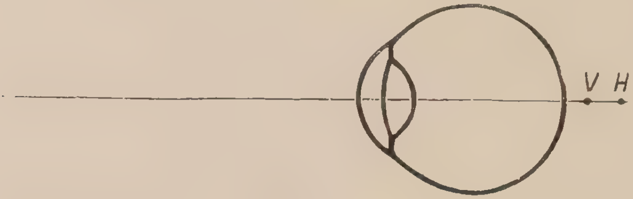


Fig. 14.

Compound Hypermetropic Astigmatism.

This is the condition when the eye is *entirely* hypermetropic (due to the axial and focal length of the eyeball not being equal) but owing, in addition, to the irregular convexity of the cornea, one set of rays would come to an earlier focus than the other. Both sets would converge outside the retina if possible. See fig. 14.

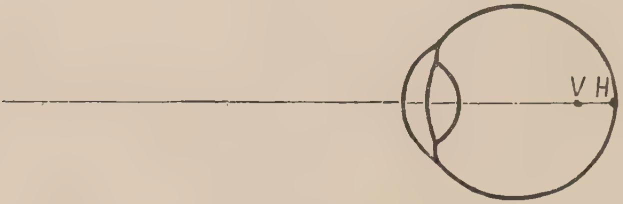


Fig. 15.

Simple Myopic Astigmatism.

This is the defect when one set of rays focusses on the retina and the other in front of it. Fig. 15.

Compound Myopic Astigmatism.

This condition bases its existence upon the fact that all rays come to a focus too soon, but one set *sooner than the other.* Fig. 16.

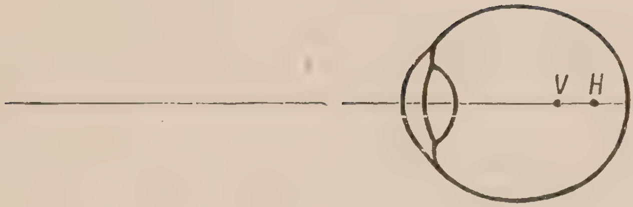


Fig. 16.

Mixed Astigmatism.

Sometimes it happens that one set of rays will focus in *front* of the retina, as in myopia, while the other would focus behind it, as in hypermetropia. This is Mixed Astigmatism.

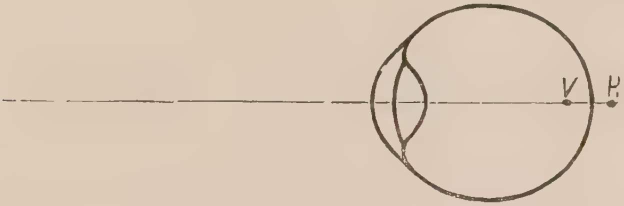


Fig. 17.

Effects of Astigmatism.

Astigmatism shows itself in a *want of definition* and its presence may be easily made manifest by the distinctness with which *lines* can be seen in different meridians. Letters are made up of lines which run in different directions, and it follows that if lines are visible in one and not in another, there must be considerable difficulty in defining the letters. For example, the letter "T" is made up of a horizontal and a vertical stroke. If one can only see the vertical stroke, the letter is mistaken for an "I." The confusion this causes in reading is obvious, and the effort constantly being made when reading to make out what the letters really are, is the cause of all the discomfort, accompanied more or less by headaches, which this defect causes. It is easy to understand therefore how astigmatism diminishes the acuteness of vision in a marked degree.

Although in many cases a slight amount of Astigmatism may be ignored, yet there are cases in which it *must* be corrected. For instance: where there exists say ·25 of Astigmatism and a strong spherical is necessary, it may be ignored, as the amount of *difference* in the acuteness in the two principal meridians is but slight. Where, however, this same amount of Astigmatism exists and a low spherical power is required it *should* be corrected. Obviously there is less difference between the two meridians where say a + 5 Sph. and + 0.25 Cyl. is wanted than when + 0.75 Sph. and a + 0.25 Cyl. is required. In the former case the astigmatism may be ignored, but not in the latter.

Rationale of Correction.

It is necessary in correcting Astigmatism to supply this want of definition, by making as it were, the horizontal stroke as clear as the vertical.

Means of Correction.

Astigmatism is *always* corrected by means of cylindrical lenses

What can be done with Cylindrical Lenses.

As therefore a cylindrical lens only refracts in the meridian at right angles to its axis, it follows that it is possible to correct a defective meridian without interfering with that which is normal; and also to give a *larger amount* of correction to a meridian which *needs more* than another.

Meridians in Astigmatism.

The meridians (Mn.) of greatest and least curvature are called the Meridians of Greatest and Least Defect (G.D. and L.D.) or principal meridians, and may be said to be always at right angles to each other. In testing by an *objective* method (retinoscopy, etc.) and by a *subjective* method (by means of lines on a revolving dial) the meridians of G.D and of L. D. are reversed: that is to say the Mn. of G.D. *according to the eye* (objective method) is that of L.D. according to the dial (subjective method), and that of L.D. according to the eye is that of G.D. according to the dial. In one case we look at the eye itself, and in the other the eye looks at the dial. If, say, a series of lines, which are counted by the normal eye at a distance of 20 feet, can only be counted when the lines are in the vertical meridian, it will be seen that this meridian is that of L.D. according to the dial. It would be that of G.D. according to the eye. One can easily understand this by placing in front of one a convex cylindrical lens with its axis vertical and considering this lens as the cornea of an astigmatic eye, a condition of simple hyper astig. — axis vertical. There is no defect in the vertical meridian of the eye. Rays of light proceeding from a luminous object — say vertical lines on a card — will pass through *both* meridians *i.e.*, V and H. In this case those which pass through the vertical are not refracted or altered in their course but those which pass through the *horizontal* meridian are bent towards the centre or thickest part of the lens bringing them to a *vertical focal line.* An indefinite number of focal points are, as it were, built up one on top of another thus forming a *line.* If such an eye is looking under these conditions it is the *vertical* lines on the card which are affected by the *vertical focal line* created, the actual focus being anterior or posterior to the true position of the vertical lines. The V meridian of the *eye* is not affected at all. This refractive effort is the same as providing a normal meridian with a convex lens *i.e.*, it must make vertical lines less distinct.

The vertical Mn. is generally that of the greatest, and the horizontal that of the least refraction; though the reverse is often the case: and other exceptions are not rare, the greatest and least curvature being sometimes found in any meridian.

When the two principal Mns. are not at right angles Irregular Astigmatism is said to exist.

"This is caused by such defects as corneal nebulæ, facets, unequal refractive indices of the sectors of the lens, and in short irregularities of any unsystematic kind in cornea or lens. *It is incapable of correction*, except partially by the employment of a stenopaic slit and occasionally by iridectomy." MADDOX.

CHAPTER IX.

ASTHENOPIA.

This condition takes one of two forms, viz., accommodative or muscular. It is therefore a state of things arising either from an abnormal refractive condition or want of inter-ocular muscular harmony.

Hypermetropia *is generally responsible for accommodative asthenopia.* Chap. IV, page 16, explains the accommodative effort necessary. In addition it may be said that every one is born with a certain amount of accommodative power; some of it intended for more or less constant use and the rest as a reserve. In hypermetropia the reserve is being constantly called upon and if the defect continues uncorrected, nature rebels, and the troubles mentioned in Chapter IV begin. Sooner or later the eyes will fail to respond to the demand made upon them and then asthenopia becomes manifest. It may become so manifest as to *blind the true cause of it.* It is upon the ciliary muscles that the continuous demand is made, resulting in a condition of what is called spasm The accommodative power is always in a state of abnormal activity, with the result that *symptoms of myopia* may appear, such as: 1, the habit of holding a book closer to one's eyes than is natural; 2, the appreciation of a concave lens. A myope is *naturally* able to exercise without fatigue a stronger accommodative effort than an emmetrope. If the hypermetrope has, through constant effort, *acquired* a condition in which the accommodative power is always abnormally active a SIMULATIVE MYOPIA results. This is always accompanied by asthenopia as a result.

MUSCULAR ASTHENOPIA may exist either with or without any error of refraction and can be easily detected by using the "Maddox" Rods with Davidson's ELECTRIC TANGENT SCALE and with Davidson's NEAR POINT MUSCLE TEST in the manner explained on page 63.

Muscular asthenopia alone, *i.e.*, without refractive error, results when the eyes do not accommodate to the same extent as they converge or *vice versa*. A small amount of imbalance can be overcome naturally; but if the amount is such that it cannot be overcome *unconsciously*, asthenopia will result. It is evident therefore that *it is the inharmonious association of the* two eyes which is the cause of this. TO DETECT THE CAUSE, *the two eyes must be disassociated* and this is the rationale of the ROUTINE OF TESTING FOR MUSCULAR INSUFFICIENCY.

THIS IS DESCRIBED FULLY on pages 59 to 69.

In accommodative asthenopia we must seek for the true refractive cause and correct accordingly. In muscular asthenopia *with* refractive errors, it is wise to correct the *latter only* at first. Prisms may be necessary later. In muscular asthenopia alone, prisms become advisable at once in the majority of cases.

DO NOT FORGET that asthenopia will be caused, *where none previously existed*, by the glasses prescribed for each eye if they cannot be worn together. I refer to cases of anisometropia, *i.e.*, where the refraction of one differs materially from the other. Finally asthenopia must be generally considered as a *result of something else* and not a condition of itself such as myopia or hypermetropia.

Symptoms of Spasm of the Accommodation (Ciliary Spasm).

The term "ciliary spasm" is generally applied to that condition which shows myopic symptoms while no myopia is present. For example, the patient may hold his book closer than is natural and he may appreciate a *concave* lens for distance. In such a case it would be *impossible* to get even a moderately good result. A comparatively slight improvement only in the visual acuity would be obtained, caused by excitement of the accommodation. In testing the acuity the patient's answers would be often contradictory. The material point therefore would be that while a concave lens was preferred to a convex yet no good result could be obtained.

Ciliary spasm exists also in cases of true myopia. In young people a fairly high degree of astigmatism will be usually present. Here again good results cannot be obtained by any subjective test. Mixed astigmatism is often associated in young people with ciliary spasm.

Nothing but retinoscopy after mydriasis should be employed to diagnose such cases: in fact all cases where good visual acuity cannot be obtained should be determined by this method.

DAVIDSON'S IMPROVED "COMPLETE SIGHT TEST,"

ILLUSTRATED.

The "Maddox" Multiple Rod can be used with this for muscle testing.

Size 30 in. x 20 in.

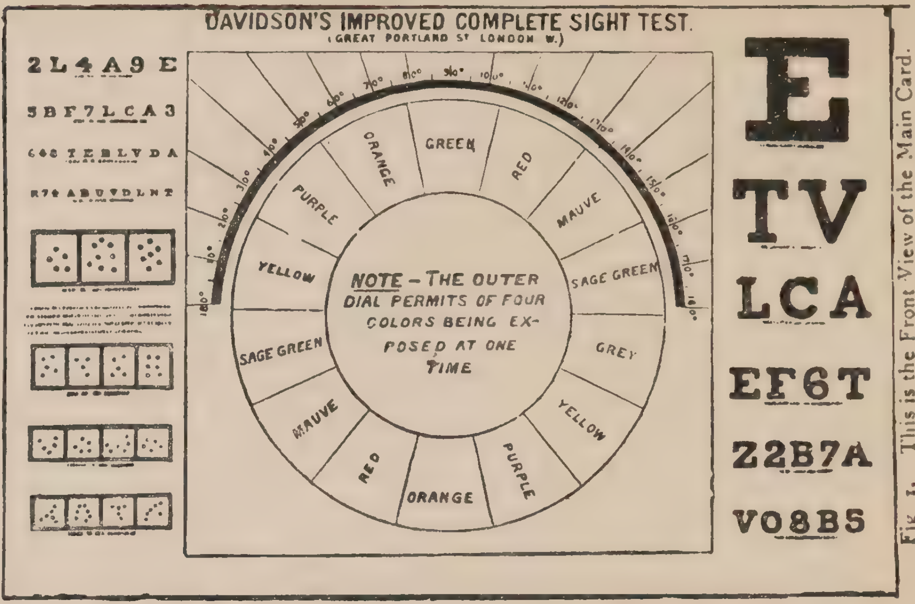


Fig 1. This is the Front View of the Main Card.

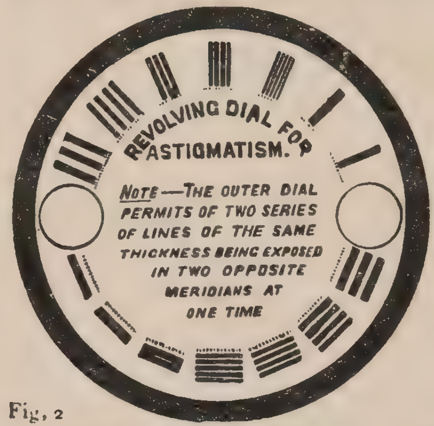

REVOLVING DIAL FOR ASTIGMATISM.
NOTE—THE OUTER DIAL PERMITS OF TWO SERIES OF LINES OF THE SAME THICKNESS BEING EXPOSED IN TWO OPPOSITE MERIDIANS AT ONE TIME

Fig. 2

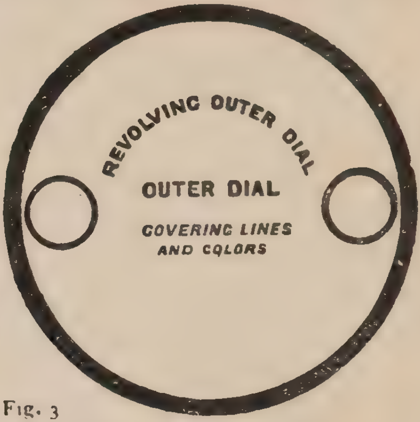
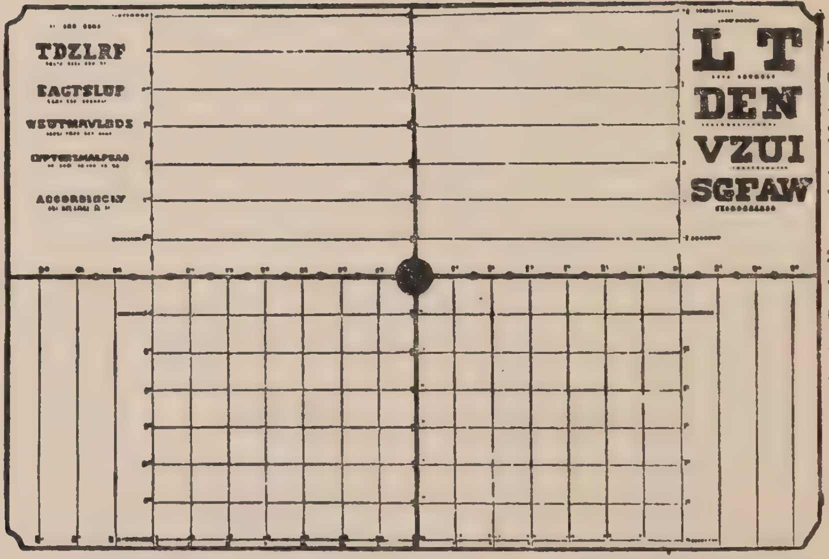


Fig. 3



Stout Card.

Fig. 4. This is the Back View of the Main Card

Tests acuteness, refraction, convergence, muscular irregularities, and colour vision, including "**Dot Test for Recruits.**"

Price alone 10/6.

CHAPTER X.

SUBJECTIVE TESTING
WITH
The Improved Complete Sight Test.

The Improved Complete Sight Test (see illustration) is made up of a large oblong card, 20″ × 30″, revolving on the centre of which are two circular dials. The inner dial has groups of lines of various thicknesses on it, and arranged in such a manner that in whichever way it is turned there are always two groups of the same size exposed *opposite* to each other and at *right angles* to each other. Under each set of lines is marked the distance in metres and feet at which the normal eye can *count* them.

The outer dial has two openings that allow of only two sets of lines being exposed at one time.

The radiating lines round the semi-circle on the main card denote the meridians at which the lines are exposed.

On each side of the main card are test letters and figures of various sizes according to Snellen, and the "dot" test for recruits.

On the reverse side of the card is a diplopia test for defects of the Ocular Muscles for use with the Maddox Double Prism.

We have therefore in this improved "Complete Sight Test" a standard by which we can measure the range and acuteness of vision far better than with letters alone or with any of the usual sundial or clock-faces. It is almost perfect for determining all errors of refraction and the various muscular irregularities met with in the eye.

If letters of different sizes can be distinguished at different distances, the lines that make up those letters can also be distinguished at the *same* distance. It is frequently the case, however, that lines which run in some *one* direction are seen more clearly than in any other, from the same point of view, and with the same adjustment of the eyes.

This peculiarity is what is called Astigmatism, and it may be said to exist to some extent in all eyes. A very small amount might not be disturbing to vision, but it is obvious that to be able to properly correct defective sight, we must have a thorough knowledge of even the slightest existent defect.

SYSTEMATIC WORK.

It is best for sight-testing to be done systematically and in every case to go through the same routine for each eye until practical experience has taught what detail may be dispensed with in certain cases.

In the method which I will now proceed to describe every step is taken with a *definite object.*

There IS A REASON FOR every question asked.

There is ONE DEFINITE MEANING to every ANSWER.

The *reason* FOR EACH SUCCESSIVE step and for THE QUESTIONS ASKED of the patient AS WELL AS THE *meaning* of his answer WILL BE given.

It is most IMPORTANT FOR the doctor to grasp these points THOROUGHLY ; then the actual testing will PRESENT little or no DIFFICULTY. *To know what you are* LOOKING FOR *and to be quite cognisant* OF THE REASON *for your question* is to GRASP THE ESSENTIALS of refraction work.

THERE IS NO REASON AT ALL FOR A RANDOM QUESTION TO BE ASKED, AS WILL BE SEEN AS I PROCEED.

CHAPTER XI.

RULES FOR TESTING.

***Rule 1.*—Naked eye on letters** (for acuteness).

***Rule 2.*—Sph. Convex on letters** (for hypermetropia).

***Rule 3.*—Cyl. Convex on letters** (for hyper. astig. or mixed astig.)

***Rule 4.*—Cyl. Concave on letters** (for myopic astig.) in the meridian made *worst* by the convex when the latter cyl. has indicated astigmatism, yet in *no* Mn. does it *improve* the sight.

In a case of Compound Hyper. Astig. Rule 3 or 4 would not apply, as a *decided improvement* would have been noticed when Rule 2 was applied.

Rule 3 is only applied when the previous one fails to clearly indicate hypermetropia.

IT MUST BE REMEMBERED THAT SIGHT TESTING IS NOT AN EXACT SCIENCE BUT ONE'S DEDUCTIONS MUST BE EXACT.

ROUTINE OF SIGHT TESTING.

Testing the Sight.

The person to be tested should be seated facing the test types, which must be placed in a good light and at a distance of *at least* 10 feet (15 feet or 20 feet is better). One eye is covered while the other is being tested.

Rule I.—First test the Distant Sight on letters with the naked eye.

In every case the *distant* sight must be tested first, as it is only by doing so that any anomalies of refraction can be determined. Testing the near vision first would only result in erroneous impressions, and a correct diagnosis as to the defect would be impossible, because the eye is not in a state of rest when looking at a near object on account of the effort of accommodation necessary; and it is only when the eye *is* at rest (as in looking at distant objects) that the state of its refractive power can be ascertained.

Testing the Acuteness.

Direct the patient to look with the naked eye at the distant types, and to read down from the largest to the smallest until the *smallest* he can read are found. Having noted the distance at which you are testing, you will at once see if the distant sight is good or deficient.

NOTE.—If $V = \frac{6}{6}$ *you may eliminate Myopia.*

Rule 2.—Testing with Convex Lenses first.

After having tested the acuteness with the naked eye it is absolutely essential that the test be continued by using *convex* lenses *first*, in order that hypermetropia may not be mistaken for myopia. It is possible for this mistake to be made, because a hypermetrope can sometimes see a little better with concave lenses, but *no one*, *unless he be hypermetropic*, *can see as well at a distance with convex lenses as with the naked eye.* Consequently the very fact of his being able to see *as well or better* through a *convex* lens is a positive proof of hypermetropia.

CAUTION.—The mere ability to see a little better with a concave lens is *not proof* of myopia.

It is well to suspect everyone of being hypermetropic.

Distant test with Convex Lenses.

In all cases, *even if the distant sight is good*, place a convex lens over the eye (a weak one, +0.50 if vision is as good as $\frac{6}{9}$, +0.75 if $V=\frac{6}{12}$, +1.50 if $V=\frac{6}{24}$, +2 if $V=\frac{6}{36}$, and so on). As, at this stage, the convex lens being used is only experimental to the extent of desiring to find out if the patient can see better with or without it, it will be understood that if $V=\frac{6}{9}$ and you used +1.50 you would be *sure* to make matters worse, whereas, if $V=\frac{6}{36}$ and you used +0.50 you would not create *sufficient* difference for him to appreciate it. Ask the patient if he can see the smallest type seen without the lens, *as well or better* through it. If he can, it proves the case to be hypermetropia. Then continue until you find the *strongest* with which he can see normally. This will be the lens to be given for distance, and constant use. If the patient cannot see as well with *any* convex lens and the distance sight is *good*, that is, he is able to read the letters at the marked distance, vision is practically normal and may be considered *absolutely* so if a *weak convex cylindrical lens makes vision worse in every meridian.* If normal vision be obtained by the convex lens the hypermetropia is said to be manifest but if only partially corrected there is always a certain amount of this defect ungetatable as it were, or hidden behind the strong accommodative effort. This is nearly always the case in *young* hypermetropes. The hypermetropia can be wholly or partly hidden and this hidden part is known as

LATENT HYPERMETROPIA.

It can be made manifest in many cases by

THE FOGGING SYSTEM.

In the hypermetrope the accommodation which is so *excessively active* brings about an increase in the refractive power of the eye and so affords better distant vision than would be the case if it were *not* possible to bring the necessary accomodation into play.

The *continual* use or rather abuse of the accommodative power becomes after awhile quite *habitual* and cannot be abandoned at will.

In the correction of hypermetropia we have to increase the refractive power of the eye by means of convex lenses, but this cannot be done in full unless the ciliary muscles relax their efforts.

The eye is subject to the control of both the ciliary muscles *and* the convex lens, with a negative result.

Before the full amount of hypermetropia can be ascertained it becomes necessary to produce *relaxation of the accommodative effort.*

By means of atropine this is easily done, but in many cases it is inexpedient to resort to use of this drug, and the subjective method known as the

FOGGING SYSTEM

may be employed with satisfactory results in many cases.

1. Use a convex lens sufficiently strong to cause the *largest* letter on the test card to appear hardly decipherable. This creates a condition of *artificial myopia* and further exercise of the accommodation in the effort to see distinctly only makes matters worse, while any *relaxation* causes *improvement* in distant vision.

2. Instead of using a blank in front of the eye *not* under examination use a *very strong* convex lens This also has a tendency to favor relaxation of the accommodation.

Tell the patient to look *easily and steadily* at the large letters of the test card while you write down the necessary general details: age, address, &c.

3. After the lapse of three or four minutes alter the strength of the convex lens over the eye under examination by placing in front of it *concave* lenses of gradually increasing power until the patient can read letters normally or $\frac{6}{6}$ and the *difference* in the power of the convex and concave lens which produces this result denotes for practical purposes the *full amount of hyper-*

metropia although it is possible that a cyclopegic might disclose a little more.

Example: The patient is "fogged" by means of a +5.0 and with —3 in addition V = $\frac{6}{6}$ is obtained. Here are two diopters of hypermetropia and in deciding how much of this it would be wise to correct, local conditions must be taken into consideration. If the patient has been in the habit of wearing glasses, almost a full correction might be given, say +1.50. If patient is young and has never worn glasses, +1.0 would be enough at first, providing the whole of the hypermetropia were latent, in other words the convex lens gave no improvement in the ordinary routine of testing. If part were manifest and part latent a little more might be ventured upon. The *constant* use of glasses and further examination after a lapse of a month or so is advisable.

The case may be considered one of *Simple* Hypermetropia only if the required standard of acuteness is obtainable with a *spherical* + lens alone.

Note.—The "Muscle Test" Chap. 17, will indicate latent hyper. where such exists.

IF THE ACUTENESS WITH THE NAKED EYE IS $\frac{6}{6}$ THERE CAN BE NO MYOPIA, no matter what myopic symptoms may be present (see reference on pages 32–33 to "simulated myopia," ciliary spasm).

Question. Why do we test the acuteness with the naked eye?

Answer. To be able to recognise normal acuteness and so eliminate myopia.

Question. Why do we test with a *convex* sph. lens first?

Answer. Because we must begin by suspecting hypermetropia.

Question. What is the proof of hypermetropia.

Answer. The ability to see *as well or better* at a distance with a convex (+) spherical lens.

CHAPTER XII.

TO DETECT SIMPLE OR MIXED ASTIGMATISM.

Rule 3.—Testing with Convex Cylinders for Simple Hyper. Astig. when Rule 2 (testing with Cx. Sph lenses) fails.

When, in testing the distant vision the convex spherical lens gives no improvement or the patient seems unable to determine whether he can see better or worse, revolve a + cylinder in front of the eye. This will in nearly every instance rapidly determine a case of simple hypermetropic astigmatism, as one Mn. will be *improved* by it and the opposite one made worse.

The smallest letters seen with the naked eye should be looked at.

The Correction for Simple Hyper. Astig.

is the + cyl. giving best vision.

If two cylinders of different power give equal results prescribe the *weaker*.

The value of testing with Convex Cylinders.

When you place a convex cylinder in front of the eye, you are, *in effect*, testing for hypermetropia in the particular meridian of the card in which you have placed the axis.

This cyl. lens therefore provides a very keen test, as each meridian can be tested to the exclusion of the others. For example, a cyl. lens +1.0 placed with its axis V *only effects* the vertical meridian of the *dial.* If the patient sees better it is obviously because he is *hypermetropic* in the vertical meridian. If, however, he does not see so well as without it, it is because he is *not* hypermetropic *in this meridian.* Care should be taken to place *no other* construction on his answer (This is subject to weaker convex cyl. lenses giving the same result). The mere fact of his seeing better in one meridian *than another* only proves the existence of astigmatism. It is hyper. astig. only if vision in one meridian is *improved* by it. In *myopic* astigmatism a *difference* in perception would be noticed *even if a convex cyl. were being used* but in such a case no *improvement* would be got by it in any Mn. whatever.

This does not exhaust the amount of information to be derived from the use of the convex cylinder; it enables one to define MIXED ASTIGMATISM also. In such a case one meridian would be *improved* by the convex cylinder, the opposite one would be made *worse*, yet good vision could not be obtained by its use alone. If this lens be discarded for a moment and the *opposite* meridian (the one at right angles to it) tested with weak *concave* cylinders with their axes in this meridian, myopia will show itself at once, as vision will now be improved.

To find the amount of defect in

MIXED ASTIGMATISM.

Note which are the hyper. and myopic meridians as disclosed by the use of the said + and — cylinders, and expose LINES ON THE DIAL in similar meridians. Test the hyper. Mn. with Convex cyls., the axes being in this meridian, *i e*, if the hyper. meridian is vertical expose vertical lines to the patient (those normal for the distance at which you are testing) and the strongest with which he can count them best denotes the amount of hyper. here. NOW DISCARD THIS LENS, and test on lines in the myopic meridian; in this case horizontal, and represented by the opposite lines; with concave cyls., axes horizontal, and the *weakest* concave cyl. with which they can be counted normally or best denotes the amount of myopia.

The way to arrive at the proper combination for the patient is described in the following illustrative case

Having learnt by means of the + cylinder that the hyper. meridian was at 15° we expose the lines on the dial marked V $=\frac{6}{6}$ M (if we are testing at 6 metres) in this meridian and find that the strongest + cylinder with its axis at 15° with which lines can be best seen here is + 2.

This lens is then discarded and the patient's attention directed to the lines in the *opposite* meridian, Mn. 105° — cylinders are now employed to test this meridian and the weakest with which they can be best seen is —1. The condition now is:—Hypermetropia of 2 D in meridian 15° and Myopia of 1 D in meridian of 105°. The sum of the two figures is the amount of the Astigmatism and will denote the power of the *cylindrical* lens required.

Correction in Mixed Astigmatism.

Formula: {Spherical + 2 ⊃ Cyl. — 3. Axis 105°,
{*or* Spherical — ⊃ Cyl. + 3. Axis 15°.

In the first correction the spherical + 2 corrects the Hypermetropia in Meridian 15°, but it makes the myopic meridian more myopic than before, to the further extent of — 2 D. It *was* myopic 1 D in this meridian before, now it is myopic 3 D, and this resultant myopia is corrected with a cylinder — 3 with its axis in this myopic meridian, namely 105°.

In the second correction, the conditions are reversed the spherical — 1 correcting the myopic meridian but making the hypermetropic more hypermetropic still, so a + cyl. is required.

RULE.—*Either* figure may represent the spherical but the *sum of the two* must be the cylinder.

If a spherical + is used a — cylinder is necessary and *vice versa.*

If a + cylinder is used its axis must be in the hypermetropic meridian: if a — cylinder is used, its axis must be in the myopic meridian, according to the dial.

When the convex cylinder affects all meridians adversely yet one is made worse than another EMPLOY

Rule 4.—Test with Concave Cylinders for Simple Myopic Astigmatism,

the axes of the cylinders being in the meridian made *worse* by the convex. If the vision with the convex cylinder is better in one meridian *than another*, but *better still* without it, in other words if the vision *is not the same* in all meridians, the meridian which was made *worse* with the *convex* cylinder is probably myopic. This is easily proved by putting in a weak *concave* cylinder with its axis in the meridian which was *made worse* with the convex. The *weakest* — cyl. giving normal vision should be given. It cannot be too strongly pointed out that the mere fact of one seeing better *in one meridian than another* does *not* prove hyper. astig. This can only be the case if vision with the convex cyl. is *improved* by it.

Question. When you place a + cylinder axis V in front of the eye and ask if the patient can see the letters better or worse, what is the meaning of your question?

Answer. Are you hypermetropic *in this meridian?*

Question. Why does your question not refer to the eye generally?

Answer. Because a *cylindrical* lens is being used and this only refracts in one meridian, not in all.

Question. Suppose the V meridian or any other is *improved* by the + cylinder, what would you do?

Answer. Try if normal acuteness ($\frac{6}{6}$) could be obtained by + cylinders alone.

Question. Suppose you could only obtain a *partial* improvement in this way, what would you do?

Answer. Suspect mixed astigmatism and test the opposite Mn. with — cylinders.

Question. When you commence using the + cylinder in the V meridian and the patient rejects it, what does this prove?

Answer. No hypermetropia in the V meridian.

Question. Suppose the patient can see better in the H meridian than in the V, what does this prove?

Answer. Astigmatism. *Nothing more.*

Question. How can you tell if it is hypermetropic or myopic astigmatism?

Answer. If hypermetropic, the vision in the meridian in which the patient can see *best* with the + cylinder will be improved as compared with the naked eye. If myopic he will see better *without* the + cylinder than with it.

Question. In the latter case which is the myopic meridian?

Answer. The one which is made worst by the + cylinder.

Compound Hyper. Astig.

If a Sph. + Lens only gives Partial Improvement, Compound Astigmatism should be suspected. When this is so the next step must be to find the meridian in which the patient is *most hypermetropic.*

How to use the lines on the Revolving Dial.

Note the *strongest* + lens which gives the best result for the letters and then fog him by putting *a stronger* one, 1 D. more, in front of the eye while you test with the lines on the dial.

Mn. of G.D. in Hyper. and of L.D. in Myopia to be discovered first by means of fogging with a strong + or weak — sph.

It is upon the discovery *first* of the Mn. of G.D. in cases of Hyper, and of L.D. in cases of Myopia that the accuracy of our diagnosis and the subsequent correction depend, so that the *strongest* convex or *weakest* concave with which lines can be best seen or normally in *any one* Mn must be *first* ascertained.

If lines are looked at with the *naked eye* the meridian in which they are best seen is that of *least defect*, but if the lines are looked at with a strong convex lens the meridian in which they are best seen is the meridian of *greatest* defect.

Find the smallest lines the patient can count or see best now in either meridian. Suppose it to be the horizontal, for purposes of illustration. Turn these lines as far as say 45° above or below this meridian and see if he can count them or see them more clearly still in any *intermediate* meridian.

We do not want to discover at this stage the *amount* of defect, but to find out which meridian is the most hypermetropic which will be the meridian *of greatest defect.*

As we are using a *stronger* convex lens than gave best results for letters, it follows that the meridian in which the patient sees *best* with this strong convex lens must be that in which he sees *worst* without it. And therefore this is the Mn. of G.D.

NOTE.—The Meridian of the *dial* is meant and *not* of the eye.

The Meridian of Greatest Defect

as shown by the *dial* of the test card is that of *least* defect of the eye. For example: If a patient can, *with the naked eye*, count vertical lines more clearly than horizontal we say that " H " is the meridian of *greatest* defect because the vision appears to be worse when looking at horizontal lines. As our method of testing is *subjective* and we test by the card, so we adjust glasses according to the *meridian* of the card. *It is easy to remember* the instruction "put the axis of the correcting cylinder in the Meridian of *Greatest* Defect of the card." It is *more convenient in every way* to call that meridian of the dial in which the patient cannot see, that of greatest defect, although, by an *objective* test such as retinoscopy, those same lines are in the meridian of *least* defect of the eye itself.

It would seem incorrect to call the meridian of the dial in which the vision was *best*, that of *greatest defect.*

On page 10 the effect of a cylindrical lens upon light is explained, and the apparent anomaly of its use by putting the axis in the Mn. of G.D. of the dial is explained, as this lens is really in front of the eye in the Mn. of L.D.

Discard this Lens.

Having by means of a strong convex lens discovered the meridian of greatest defect, the lens *has served its* purpose and should be discarded.

To determine the Sphero-Cylinder necessary in cases of Compound Hyper. Astig.

The patient is now directed to look at the lines exposed in the *opposite* meridian and at nothing else. These lines are obviously in the meridian of *Least* Defect, and this is the meridian now to be tested for the *amount* of defect. This is represented by the power of the *strongest* convex lens with which lines can be best seen here, *and this will be the spherical lens required.* Now, with this lens direct the patient's attention to the smallest *letters* he can read. and if normal vision cannot be obtained with this alone, add to it convex cylinder lenses with the axes in the meridian of *greatest* defect, until the one which gives the best result is found. This would be a case of Compound Hypermetropic Astigmatism.

Example : Patient cannot read letters normally and the sight is only improved slightly by convex lenses : + 1 is a little better, but + 1 50 is worse. He now looks at the two thickest sets of lines exposed in the H. and V. meridians with + 1.50 and gradually exposing smaller lines those marked 9 M are seen best in the H. meridian. *These lines only* are now looked at and it is found that they are seen more plainly still when turned to 15°. This is the Meridian of Greatest Defect.

This + 1·50 is discarded and the patient now looks at the set of lines which are exposed in the opposite meridian (105°), and the strongest convex lens with which the lines are counted normally is + 0·75. This is the spherical lens wanted and the patient now looks at the *letters* with it. It does not, however, give normal results, so convex cylinder lenses with their axes at 15° are placed in front of the spherical + 0·75, and beginning with say + ·50 and trying successively + ·75 and + 1, find that with the latter, best results are obtained. The axes of the cylinders are placed in the meridian of Greatest Defect according to the dial, but care should be taken to *prove* this by revolving the cylinder a little to the right or left until the meridian is located by the patient in which the letters have the clearest definition.

Formula: Spherical + 0·75 $\overset{\frown}{\smile}$ Cyl. + 1 axis 15°.

CHAPTER XIII.

MYOPIC CONDITIONS.

Exhaust the use of Convex Lenses in every Mn. before using Concaves.

THE sight having been tested with the letters and it having been found that the *distant vision was defective* and was *not* improved with either convex sph. lenses, or convex cyls., myopia may be suspected.

Find *absolutely the weakest* concave spherical lens with which the letters can be read normally, and this will be the lens to give for distance. If, however, a normal result is not obtained, Astigmatism may be suspected.

Use weaker Concave Lens for lines than for letters to determine the sphero-cylinder necessary in

COMPOUND MYOPIC ASTIGMATISM.

Find the *weakest* concave lens which gives the best result for letters and using a *weaker* one, find the meridian in which the patient sees the lines best (Mn. of L.D.) and then the weakest concave with which they can be counted normally, *i.e.*, can count those he ought to count at the distance at which you are testing, will be the spherical element necessary. Now with this lens direct the patient's attention to the letters, and adding concave cylindrical lenses with the axes in the meridian of greatest defect (the one at right angles) find the weakest with which letters can be read normally.

Example: Distant vision is $\frac{6}{36}$ and not improved with either + Sph. or + Cyl. lenses. The weakest concave lens giving best results with letters is — 2·0 D. *Lines* are now looked at with a weaker one, say 1·50 and it is found that in the horizontal meridian they can be counted with as weak a lens as 1 D. In the vertical meridian this lens is not sufficient. With this —1·0 the patient looks at the letters and beginning with weak cylinders and adding cylinder —2 Axis vertical (this being the weakest) letters can be read and lines in both meridians counted.

Formula: Spherical —1· $\bigcirc$ Cyl. —2· Axis V.

Strong Near Sight.

Cases of *Strong* Near Sight frequently require weaker lenses to read with, as the lenses that correct distant vision minify too much for reading.

Weaker Lens for Reading.

Where	– 8·0 D.	suits for distance	—5·50 D.
,,	—13·0 D.	do.	—10·0 D.
,,	—20·0 D.	do.	—18·0 D.

As a rule leave about 2·50 of the myopia uncorrected.

In prescribing lenses for HIGH MYOPIA *great care* should be exercised to avoid over correction. As the spectacles will be worn *nearer* the eye than are the lenses of the trial frame, while the test is being made, those ordered should be a little *less*, say half a dioptre for every 5 D of myopia.

In case of doubt always err on the safer or *weaker* side.

CHAPTER XIV.

HYPERMETROPIC ASTIGMATISM WITH PRESBYOPIA.

Cyl. Lens is the same for both distance and near work.

These cases require the cyl. lens that corrects the astigmatism to be *added* to the sph. lens that corrects the presbyopia.

For example, patient 50 years of age requires for distance, cyl. + 1·0 Axis V. On account of his age he will probably require about +1·5 sph. to correct his presbyopia, so he would need for reading, etc :—

Formula; Sph. +1·0 with Cyl. +1·0, Axis V.

Example 2.—Patient 50 years of age requires for distance Sph. +2·0, Cyl. +2·0, Axis 60°.

For reading, etc, he would probably need Sph. +3·50, with Cyl. +2·0, Axis 60°.

(The sperical lens for the presbyopia is added to the spherical for the hypermetropia, the cyl. lens remaining the same for both distance and reading).

Being *hypermetropic* he would, in effect, show more presbyopia than an emmetrope of 50.

CHAPTER XV.

MYOPIC ASTIGMATISM WITH PRESBYOPIA.

See page 23, *PRESBYOPIA WITH MYOPIA.*

NOTE.—The effect of a concave lens on a normal eye is to make it hypermetropic, and, of course, a hypermetropic eye *more* hypermetropic.

The effect of a convex lens on a normal eye is to make it myopic, and a myopic eye *more* myopic.

It is easy, therefore, to make any *meridian* myopic or hypermetropic by the use of + or – cylinders. For example: a Cyl. + 2 0 Axis V. will make the vertical meridian *of the card* myopic 2 D. if it were previously normal, but if there were already any myopia, it would *add* 2·D to this. If this meridian were previously hypermetropic to any extent *less* than 2·0, the effect of this Cyl. +2·0 Axis V, would be to make it myopic to the amount of the difference.

When it is remembered that myopia neutralizes the effect of presbyopia, some calculation is necessary when we have to deal with cases of myopic (or mixed) astigmatism in presbyopic patients. If a person over 40 years of age should have, say, 1·0 D of myopia in the V Mn, and normal vision in the H Mn., there will be the natural amount of presbyopia to deal with (according to his age) in the H. Meridian, while in the V. Mn. (again according to his age) *all or part* of it is neutralised by the 1·0 D of myopia in this Mn.

Two Methods of Correcting.

There are two ways in which this combination can be corrected; one is by adding to the — cyl. required for distance the sph. + for presbyopia; the other way is to give for reading *exactly the* opposite cylindrical correction to what is wanted for distance. For example:

Patient 50 years of age requires for distance, Cyl :— 1·0, Axis V.

The correction may be, say, Sph. +1; Cyl. 1·0, Axis V, or

The simpler formula, Cyl. +1·0, Axis H.

The best Correction.

The latter correction is the better, as it will generally be found to give a better range, and a lighter lens can be made. The effect of this Cyl. + 1, Axis H., is to make the patient as artificially myopic in the Horizontal Mn. as he is naturally in the Vertical Mn and so to equalise the defect.

The principle of the correction in all cases of Myopic Astigmatism of 3·0 or less.

A myopic eye of 1·50 D would *have a far point* at about 26 inches, and would also be able to see *much nearer* than the normal eye, so at 50 years of age no *convex* would be necessary for reading. If the patient were, say, 70 years of age, he would have probably more presbyopia than could be neutralised by this amount of myopia, and would therefore require *in addition* to the Cyl. +1·50, Axis H, a Sph. Convex of sufficient strength to enable him to see near enough. Therefore *the best method* of procedure in all cases of myopic astigmatism (up to 3.0) with presbyopia is to *first reverse the cylindrical correction for distance*, and if this is not sufficient to enable small print to be read near enough, add to this a Sph. Convex of the required power, always remembering that it is the *weakest* that must be given.

Remember the effect of making patient equally Myopic.

It is necessary when giving a + Cyl. in order to make the patient myopic equally in every Mn. to remember what must be his *far point for reading* when this is done. If he requires for distance say, Cyl.—4·0, Axis 60°, and you reverse this Cyl. giving Cyl. +4·0, Axis 150°, you make him equally myopic in every Mn. with a *far* point at 10 inches. This is too near.

Sph. + required with Cyl.

In such cases, when the myopia is over 3.0, give a sph. + with the same — cyl. required for distance.

Compound Myopic Astig. and Presbyopia.

Take a case in which there is Myopia in the V. Mn. of 1·50 D, and in the H. Mn of 0·75 D. For distance the correction would be Sph. — 0·75 ⁐, Cyl. — 0·75 Axis V. Suppose the patient to be, say, 50 years of age, the best way to correct his presbyopia would be to first make the V. Mn. as myopic as the H. Mn. by giving a Cyl. —0·75, Axis V. He is now equally myopic in every Mn. to the extent of 0·75, which is sufficient at this age. At 60 to 65 give cyl. +0·75, Axis H. This makes him equally myopic to 1·50, and if it does not enable him to see near enough, add to it the weakest convex spherical that will.

CHAPTER XVI.

MIXED ASTIGMATISM WITH PRESBYOPIA.

The principle of correction is the same as in cases of Myopic Astigmatism and Presbyopia, when the Myopic Mn. requires —3.0 or less.

The guiding principle in determining the lenses to be given for this is the same as in the former combination, that is, *first make the patient equally myopic* by giving a Cyl. + lens with its Axis in the Hyper Mn., of the strength of the Hyper and Myopia combined: for this denotes the *amount* of Astigmatism.

For example: Patient 60 years of age has Hyper. in the V. Mn. of 2·D, and myopia of 1·D in the H. Mn., the formula for distance might be,

Sph. —-1·0. Cyl. +3·0, Axis V.

The Cyl. +3·0, Axis V, *alone* has the effect of correcting the Hyper. in this Mn., but leaving it myopic 1·0 D. The H. Mn. is naturally myopic to this extent, so the patient is now *equally* myopic in every Mn. (to the amount of 1·0 D). So to the Cyl. +3·0, Axis V, add a Sph. + lens of the required strength, if the former is not sufficient *by itself* to enable small print to be read near enough.

Where there is Myopia in one Mn. more than 3.0.

If we have to deal with a case of Mixed Astigmatism in which there is a larger amount of myopia than 3.0 it is wiser to retain the — cyl. and add + sphericals to give comfortable reading vision, or to use + cyl. and *reduce* the — spherical.

Example. In V Mn. there is hyper. +2 and in H. Mn. myopia —4. You may prescribe Cyl. —6 Axis H. with a +sph. or Cyl. +6 Axis V with—1.50 sph., whichever formula the patient likes best.

Note.—It will be conceded that it is impossible to lay down hard and fast rules for sight testing. Every case will present its own peculiarities, but a careful perusal of the foregoing pages will enable the medical practitioner to do a vast amount of refraction work easily and correctly.

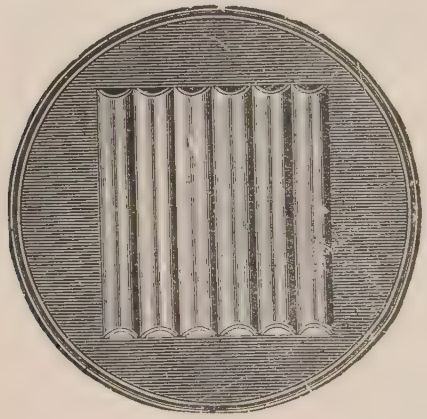
CATARACT.

Test the same as for hypermetropia and presbyopia, giving the strongest convex that gives the best result for distance and the weakest convex that gives the best result for reading.

CHAPTER XVII.

TESTING THE OCULAR MUSCLES.

The 'Maddox' Multiple Rods.



THESE are a series of cylindrical bars, which, when held in front of one eye (both eyes being open) while the patient looks steadily at a light, *disassociates* the two eyes. The *shape* of the light is altered, *but not its position*, unless there is *want of harmony* between the functions of convergence and accommodation or general muscular imbalance. This want of harmony is a fruitful source of

HEADACHE

(See page 31 *on ASTHENOPIA).*

This test will be found to be of considerable value in diagnosing many obscure cases. Its value cannot be over estimated in these cases of headache when reading; the visual acuteness having been tested and found to be normal.

Muscular irregularities may exist in *addition* to errors of refraction. These latter must be discovered first and the prismatic correction added to the refractive; care being taken to avoid using prisms in those cases in which it seems indicated that the defective muscular condition may be produced by the defective refractive condition.

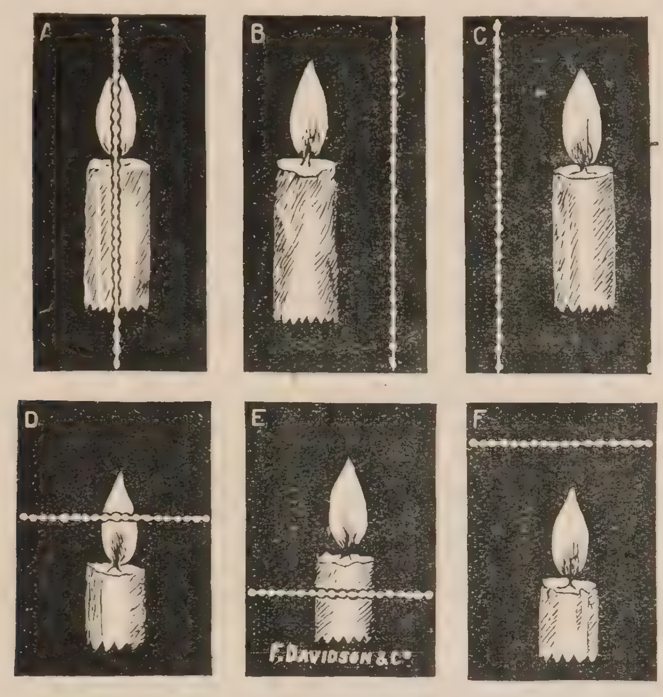
NOTE.—In advising the use of prisms in certain cases, I do so feeling absolutely sure of the beneficial results to be obtained. It must be remembered, however, that the *amount* of prismatic force that it is *advisable* to use, varies considerably in different people. As the eye behind a prism is *forced* to turn in a certain direction so the *amount of force* that eye can bear to have continually applied may not be accurately determined at first. For this reason it is advisable to use weak prisms at first and change to stronger if found desirable.

It is necessary when ordering prisms to advise the patient that he will in all probability be somewhat uncomfortable at first. A fortnight or three weeks will in some cases not be too long a time for him to become accustomed to having this *force* applied. He *may be* conscious of an improved condition of his eyes, *while at the same time* feeling discomfort in another direction. This is what has to be guarded against. He would probably think the glasses were unsuitable if he were not warned of their action.

The 'Rods' are first placed in front of the eye horizontally, the patient looking at a candle or gas flame, or electric bulb (both eyes being kept open). *To the eye being tested* the flame will appear as an elongated bar of light or a red streak. In normal conditions the position is as shown overleaf at A, otherwise as at B or C.

If when the rods are held horizontally in front of the eye the red vertical streak appears *away* from the light, but on the *same side* as the eye being tested, that is to say to the right with the right eye or to the left with the left eye, the eyes converge too much (esophoria).

If the conditions are reversed they *diverge* (exophoria) when at rest.



THE 'MADDOX' RODS FOR TESTING THE OCULAR MUSCLES.

When the 'Rods' are placed vertically before the eye, a *horizontal* streak appears: as at D if conditions are normal, otherwise below the light as in E—left Hyperphoria, or above the light as in F—right Hyperphoria. The prism which, with its base in the direction of the deviation, brings the streak into its true position shows the *amount of deviation.*

THE CORRECTION

of muscular deficiency is arrived at by first adding together the total amount in both eyes.

Providing this is less than 16° give as the LIMIT of Correction one-eighth of this for each eye, *as a maximum.*

It is inadvisable IN ANY CASE to use a stronger prism than 4°.

The *limit* of prismatic correction should *never* be given at first. The best correction is half the limit. It is *much* better to give this and change the prisms as subsequent examinations indicate the advisability of doing so.

Position of base of Prism.

The position of the *base* of the correcting prism is of *vital* importance. This is *always* placed in the direction of the deviation.

Example No. 1.

If on testing the *right* eye with rods horizontal the red streak is seen by the patient 6° to the *right*, and on testing the *left* eye it is 2° to the *left*, the correction would be arrived at as follows: $6 + 2 \div 4 = 2$ which would be the *limit* of prismatic force allowable. It would be best to give at first about half of this.

Formula. B. E. (both eyes) Prisms 1° Bases OUT.

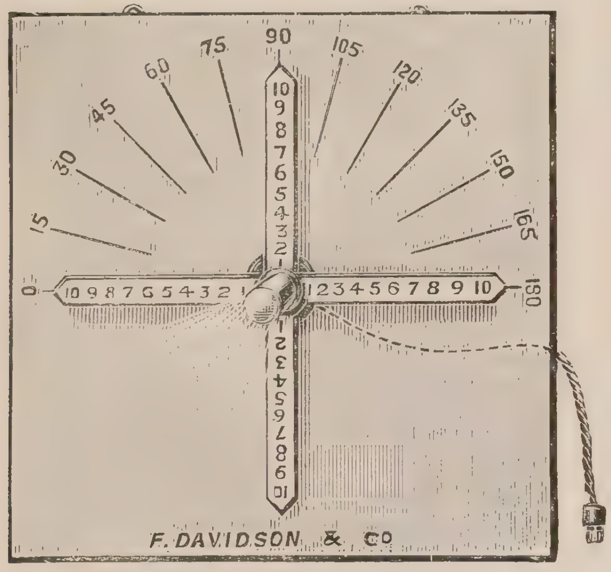
Example No. 2.

With rods horizontal the red vertical streak is seen by the *right* eye 3° to the *left* of the light and with the *left* eye 9° to the *right* of the light.

$3 + 9 \div 4 = 3$. *This is the limit.* Formula (at first) B.E. Prisms $1\frac{1}{2}$° Bases IN. If on testing with the Maddox Rods *Vertical* the horizontal streak is above or below the light, the formula is arrived at in the same way. The bases of the correcting prisms will be *up* or *down* according as to whether the *deviation* is *upwards* or downwards.

If the test with the rods horizontal shows either esophoria or exophoria, and when the rods are vertical hyperphoria is *also* shown, a compound defect exists and may be corrected as explained in the directions in the next chapter.

DAVIDSON'S ELECTRIC PHOROMETER.



The simplest appliance made for detecting esophoria, exophoria, hyperphoria or compound muscular troubles, and showing the correction necessary together with the proper position for the base of the required prism.

Price 21/- or with "Davon" battery 6/- extra.

DIRECTIONS FOR USE.

The testing distance is 10 feet. The lamp in the centre is connected to a "Davon" dry battery of 4 volts.

A special intense red lens is supplied for use with this appliance. It is placed over one eye while *both* are kept open and the light is looked at.

A red light will be seen with one eye and a white light with the other. The patient is asked but one question, viz: "Where is the red light?" If it is seen on the *same* side as the eye being tested, *i.e.*, to the right with the right eye and on the *horizontal* line, *esophoria* is indicated. If the red light is seen to the *opposite* side and on the horizontal line *exophoria* is shown. If seen *above* or *below* the light and on the vertical line hyperphoria is the condition. If seen above and to the right (with the right eye) = esophoria and right hyperphoria, if to the left and above = exophoria and right hyperphoria, if to the right and below = esophoria and left hyperphoria, if to the left and below = exophoria and left hyperphoria.

In conditions of the simple troubles such as esophoria, exophoria and hyperphoria the *degree* or amount is indicated by the position of the red light on the horizontal or vertical arm. The figure corresponding to the position of the red light shows the power of the prism required over each eye to produce normality.

When the red light is seen in any of the four quadrangles the horizontal arm on that side is rotated until the red light impinges on it, when the degree of prism may be read off as before mentioned. *The arm will then point* to the meridian in which the base must be placed.

RULE.—*In every case of muscular insufficiency the base of the correcting prism is placed in the direction of the deviation.*

EXAMPLES.

RIGHT eye being tested.

1. Red light to the *right* on H line: base to the right or *out.*

2. Red light to the *left* on H line: base to the left or *in.*

3. Red light *above* the white and on the V line: base *up.*

4. Red light *below* the white and on the V line: base *down.*

5. Red light to the right and *above:* horizontal arm is brought to the angle of 135° on the chart when the red light impinges on it: base must be at 135° or upwards and outwards.

6. Red light to the left and above: H arm pointing to 45°, base of prism is required to be placed at 45° or upwards and inwards.

Each eye should be tested separately.

The great advantage of this test is the accuracy obtained without placing any demand upon the intelligence of the patient. The answer to the question "where is the red light?" furnishes the desired information.

CORRECTION.

One-fourth of the *total* amount of deviation as indicated *i.e.*, the amount in each eye to be divided between each eye. This is the *maximum* advisable—a little less is better to begin with.

It will be seen from the foregoing that the test depends upon the disassociation of the two eyes in order that we may know *whether the visual axes of the two eyes are directed to the same spot.*

Whether the Maddox Rods or the special red lens be used, it is only the *shape* or *color* of the light which is changed. Any *difference in position* is caused by the existing muscular imbalance. If, for example, the right eye sees the red streak or the red light to the right or left of the white light, obviously this false position represents the spot to which the visual axis of the right eye is directed. The true position is of course that of the *white* light.

GENERAL OBSERVATIONS ON THE ABOVE.

Esophoria indicates convergent power in *excess* of accommodation, *i.e.*, the latter power is deficient. It will be remembered that this is a *hypermetropic* condition, therefore *esophoria indicates hypermetropia* in most cases, even though none of the latter has been discovered. *Latent* hypermetropia is to be suspected in such a case and only retinoscopy under a cyclopegic will reveal it. No prisms are required; but a *full* correction of the refractive error and its *constant* use, in spite of any discomfort caused. Some time, in many cases two or three months, would be required before the lenses could be worn comfortably.

It may be taken therefore as admitted that esophoria is nearly always associated with hypermetropia.

Esophoria *may* be found, however, in myopic cases. Prisms bases *out* will be of benefit; but close work should be given up for a time.

EXOPHORIA indicates accommodation in *excess* of the convergence.

When hypermetropia is associated with exophoria, we know that the normal relation has been disturbed, and such cases usually suffer from asthenopia and are difficult to treat. In the first condition the use of convex lenses corrects both the hypermetropia and the esophoria; but, in the second case, while the convex lens corrects the hypermetropia, it only aggravates the exophoria. Hence, we must keep the convex lenses weak, or else we must do something to neutralise the adverse effect of the convex spherics on the exophoria, or both (by adding prisms).

Where exophoria exists in presbyopes, inexperienced operators usually increase the spherical correction. This is quite wrong. Keep the spherical as weak as possible and add prisms bases in.

Convex lenses always tend practically to induce or increase exophoria. They provide *accommodative* power; therefore if this function is already in the ascendant and you still further increase it, the effect is to make the difference between the two functions *still more* than it was.

When we find exophoria with myopia, the *myopia should be fully corrected*, and prisms bases IN added if the exophoria is of marked degree.

Exophoria is nearly always an accompaniment of *high* myopia. The accommodation in a myope is *always* in excess of the convergence. It is the excessive and continuous demand upon the convergence that causes *progressive* myopia.

When we find exophoria with hypermetropia, the hypermetropia should not be fully corrected.

When we find a small amount of muscular error and a large amount of refractive trouble it is reasonable to suppose that the latter is the cause of the former, and so prisms should not be given until at least the result of the full refractive correction has been practically ascertained.

THE VIRTUE OF CORRECTING PRISMS lies in *weak* ones: not in strong.

It must never be lost sight of that the eyes are capable of overcoming a considerable amount of muscular insufficiency if due to want of *convergent* power, less if due to deficient accommodative power and less still if a condition of *hyperphoria* exists, *i.e.*, a deviation of the visual axes one above the other. It will be obvious therefore that while one would have to correct a hyperphoria of 3 or 4 degrees, one could, to a great extent, ignore this amount of exophoria. This amount of esophoria would of course make one suspect hypermetropia.

Muscular Conditions for Near Work.

It is always necessary to supplement the muscle test for distance by the test at a near point, as there is a much greater effort of both convergence and accommodation necessary. To do this we again disassociate these two functions, or in other words we cause *each eye to work alone.*

The electric "Near Point Muscle Test" is a convenient form of making this test. It consists of a frame in which is inserted a *black* card having printed thereon a line of *white* letters with a white arrow in the centre. Under the letters is a tangent scale of degrees. The centre of the card is perforated and a small electric light is shown through it. A piece of ribbon 13″ long is attached, one end to the frame and the other to a holder in which the MADDOX RODS are placed.

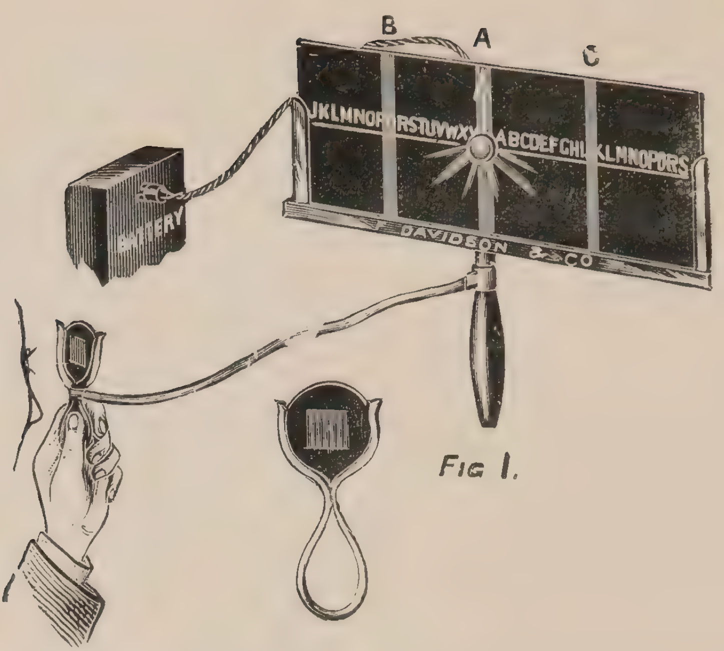


Fig I.

Instructions for use of the Electric Near Point Muscle Test.

The Maddox Rods should be first held *horizontally* in front of one eye (say the right), both eyes being open, while the card is held at the full length that the cord will permit. The plug being inserted in the battery the patient will see through the rods a red streak, while at the same time with the uncovered eye, he will see a naked light. The position of the red streak in relation to the light indicates the presence of either Esophoria or Exophoria, as in the former case, the red streak will be to the right of the light and in the latter case to the left of the light. A slight amount of Esophoria is a natural condition; but if it exists to a marked extent, it points to the existence of hypermetropia. The full amount should be discovered by retinoscopy and glasses prescribed for constant use which fully correct this defect. The correction of the Hypermetropia will automatically correct the Esophoria. The degrees marked under each letter denote the power of the prism for each eye necessary to produce normality.

If Exophoria is present, this indicates want of fusion power. If no Esophoria or Exophoria at all is present, let the rods be held in front of the eye vertically, while the card is held so that the arrow is horizontal. A horizontal red streak will now be seen through the light if conditions are normal, or above or below the light in abnormal conditions. In these cases, prisms should be prescribed, bases up or down. It should be remembered that convex lenses induce *Exophoria*, so, if cases arise in which convex lenses are needed for visual purposes—yet this test shows a condition of Exophoria,—the convex lenses should be kept as weak as is consistent with vision, and prisms, bases IN added.

It is wise for both the distant and near muscle tests to be applied in all cases. But a very few minutes is necessary for the purpose and much valuable information is rapidly obtained. The latter test should be applied both *with* and *without* the glasses which it is intended to prescribe for reading, as while they may be correct for each eye alone, it may not be possible for the patient to wear them.

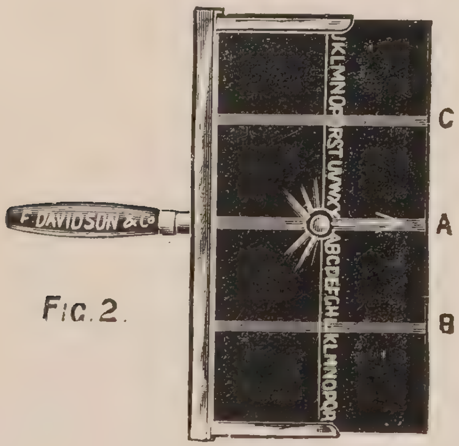


FIG. 2.

CHAPTER XVIII.

Muscular Exércises.

When the internal recti are weak, a fact which is made known by the existence of marked exophoria, much may be done by means of certain muscular exercises, to strengthen them. It is useless, however, for this to be attempted unless the art of *patience* is there on the part of both the doctor and more especially of the patient. The great convergent effort that is necessary to maintain fusion or binocular vision can be easily illustrated. Hold a finger at arm's length and fix it, then slowly bring it closer to the eyes. Presently you will become conscious of a necessary effort and as you bring it still closer the effort becomes painful. This illustration really furnishes one of the simplest muscular exercises. As soon as the fusion effort cannot be sustained—diplopia resulting—the finger should be receded and this gradual alternation of distance and near point will, if done quite a number of times at each visit of the patient and systematically persevered with each day, most certainly strengthen the weak muscles. Another excellent system of exercise, and even a better one, is carried out by the doctor himself in the following way. Let the patient look at a small light and beginning with say a 6° prism base *out* in front of one eye gradually increase the power until you find the strongest he can overcome, *i.e.*, with which he can maintain fusion. In using prisms thus, diplopia is created. This calls for the use of any reserve power of convergence there may be in order to retain binocular vision. The weak muscles, *i.e.*, the internal recti, are called upon for active work. This exercise should be persevered with until he is able to overcome as much as 30° over one eye or 15° over each. If this result can be obtained you will have cured the exophoria. It is of course not always possible to do this.

CHAPTER XIX.

Anisometropia.

THIS is a condition of defect either of a different nature or to a different degree of the same nature. *E.G.*—One eye may be hypermetropic and the other myopic or both eyes may be *either* hypermetropic or myopic but to a greater extent in one than the other. In correcting such cases it must be borne in mind that lenses create prismatic effects to a greater or less extent according to their power. If therefore there are two lenses of different foci in front of the eyes the *unequal* prismatic effect must be overcome by muscular effort which cannot in some cases be continued for any length of time. When this is so, the correction must be altered to such a point as will permit of the functions of accommodation and convergence working in harmony.

Note.—DAVIDSON'S ELECTRIC NEAR POINT MUSCLE TEST enables one to easily discover and rectify such troubles.

It must be remembered that in cases of anisometropia it is the least defective eye that does the most work, and in some cases the other eye does not participate to an extent sufficient to keep it from deteriorating from non-use. This applies in cases where both eyes cannot be corrected to equality. Children, especially young squinters, are often troubled in this way. It is a good plan to advise the use of a blank disc over the better eye while the other is systematically exercised in reading the smallest print that it can see, without too much effort, for about half an hour each day. Excellent results are often obtained in this way, even to the extent of bringing up the acuteness to that of the other eye.

Amblyopia.

This is the term used to denote the condition of a defective eye which cannot be corrected so that it can be used : the other eye being normal or, if defective, capable of correction and use.

CHAPTER XX.

The use of Cyclopegics.

I HAVE been frequently asked by medical men whether it is necessary to use a cyclopegic in all cases and also whether retinoscopy is always essential.

My experience is that the *great majority* of cases can be done without either one or the other, but there are certainly a proportion for which both are essential.

The following rules are good to notice:

"There are three classes of patients for whom the preliminary use of a cyclopegic is almost *essential.* They are—

(*a*) Young myopes under 16.
(*b*) Young squinters.
(*c*) Young astigmats.

There are likewise two classes for which it is *highly advantageous*, though not always essential. They are—

(*d*) All hypermetropes *younger* than twenty.

(*e*) Hypermetropes, under forty-five in which correction without cyclopegic has failed to relieve asthenopia." *Maddox.*

"CAUTION.—In this last group bear in mind the DANGER of starting an attack of GLAUCOMA. After 35 it is always safer to use homatropine." *Maddox.*

Mr. PERCY DUNN advises the following formula:

R. Homatropine Hydrobromatis grain iv.
Sol: Cocainæ Hydrochloratis (2 p.c.) ad. ℥ I.

The effect of this passes away in a few hours. Two or three drops should be instilled into the conjunctival sac at intervals of say 15 minutes. Half an hour after the fourth instillation the eyes would be ready for examination.

CHAPTER XXI.

Retinoscopy.

THE operator should be at a distance of 1 metre (40 inches) from the patient.

If the ordinary form of mirror is used, the light should be placed above and sufficiently behind the patient's head to leave the eyes in shadow.

If no cyclopegic has been used, the patient should look into distance so as to induce relaxation of the accommodation.

If the accommodation has been paralysed, the patient may look at the mirror.

The light is then reflected on to the pupil and the reflex looked for.

HERE THE PRINCIPAL DIFFICULTY BEGINS, as it is not easy for the inexperienced to so manage his light that, having once obtained a view of the reflex, he can KEEP IT IN VIEW while studying the shadow movements, &c.

DAVIDSON'S PATENT ELECTRIC OPHTHALMOSCOPE eliminates the difficulty and a tyro can learn to use it in half an hour. No dark room is wanted.

The light, being self-contained in the instrument, can be *kept on the pupil*, and the head movements followed during the whole time the examination is being made. For children it is specially good.

The operator first looks for the reddish reflex of the fundus, in appearance like a miniature sun. He does *not* look for the *details* of the fundus.

When in view, he notices if it is bright or dull. If the former, the defect, if any exists at all, can only be of small amount.

RULE. The brighter the reflex the less the defect, or *vice versa*.

After noticing this, the operator revolves the mirror, first on its vertical, then on its horizontal axis. Holding the ophthalmoscope or retinoscope with the handle vertical, the reflection thrown on the patient's face (caused by the lamp and mirror) will move horizontally when the instrument is revolved from right to left or *vice versa.* When the instrument is held horizontally and revolved in an "up and down" way, the reflection will move vertically. In the former case the operator would be testing the horizontal meridian of the eye and in the latter the vertical. Now he looks for a black shadow which will move across the illuminated area as the mirror is revolved. In other words he looks for an eclipse of the sun and notes whether the movements of the shadow are *with* the reflection or against it. Only infinitesimal movements of the mirror are required.

I advise a plane mirror as the shadows appear with more clearly marked outline, although with a concave mirror, more light is concentrated on the pupillary area. If therefore, with a plane mirror, the shadow moves "with," hypermetropia is indicated. Find the weakest convex lens which *reverses* this shadow movement, *i.e.*, that makes the shadow move against and the *previous* one will represent the *amount* of hyper. to be dealt with. If the shadow does *not move* "with" the reflection or moves "against," then the eye is myopic. Find the weakest concave lens which will cause the shadow to move "with," and the previous one will denote the amount of myopia.

CERTAIN ALLOWANCES MUST BE MADE in all retinoscopic results.

Firstly. For testing at a distance of 1 metre.

Secondly. For the use or non-use of atropine.

In the first case the eye being tested is adapted for infinity, so as you would be testing at a metre distance, this must be taken into consideration.

If atropine is not used:

RULE. Deduct 1 D. from the hypermetropic result shown.

Add *not more* than 0.50 to myopic results.

A NORMAL EYE WILL SHOW ITSELF BY RETINOSCOPY TO BE HYPERMETROPIC TO THE EXTENT OF +0.75 to 1, so that in a case in which even a +0.25 caused a reverse shadow the eye would be myopic.

The *theoretically correct* addition would be 1 D, but in practice this proves to be a higher correction than is advisable.

IF ATROPINE IS USED deduct 2 D. from the hypermetropic result, but do not add *more* than 1 D. to a myopic finding.

Less than this is often advisable.

If the eye being examined is astigmatic it will not be possible to get a spherical lens that will reverse the shadow movement in all meridians. Under such conditions, reverse it in *one* meridian first and then do likewise in the meridian at right angles. FOR EXAMPLE, —Using a plane mirror the shadow moves "with," indicating hypermetropia. Sph. +2.25 is the weakest with which the shadow moves "against" when moving the mirror to and fro in the *vertical* meridian of the eye, *i.e.*, the reflection moves vertically. In the horizontal meridian of the eye the shadow still moves "with" but by using a +3 the shadow is reversed. Therefore there are 2 D of hyper. in the V meridian and 2.75 D. in the H meridian.

RULE FOR CORRECTION. The *weaker* of these two lenses is the sph. lens required and the difference between them denotes the necessary cylinder: always subject to the deductions previously mentioned. The axis of the cylinder is always placed in the meridian of *least* defect; in this case V.

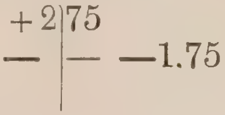
The same rule applies in a case of myopia, the testing being done of course with *concave* spherical lenses.

In an eye not under the influence of a cyclopegic a case of SIMPLE HYPERMETROPIC ASTIGMATISM would be shown by one meridian showing hypermetropia of 1 D. and the one at right angles to it *more* than this. In such a case the *difference* between the two amounts would denote the power of the *cylindrical* lens alone required.

SIMPLE MYOPIC ASTIGMATISM would show itself by revealing one meridian to be slightly hypermetropic and the opposite meridian not so much, *if at all.*

IN MIXED ASTIGMATISM one meridian will be seen to be hypermetropic and the opposite one myopic. In such a case find the weakest spherical convex which causes a reverse movement in the hyper. meridian. Then find the weakest concave spherical lens which does likewise in the myopic meridian.

EXAMPLE. In the V meridian +3 is the weakest lens which causes the shadow to move "against" the mirror. In the H meridian —2 is the weakest which causes the shadow to move "with" the mirror. The actual condition is here illustrated.



Note. The +3 and —2 *over corrected* each meridian respectively.

Rule for correction. Either figure may be taken as the spherical element required, but the sum of the two figures must be the cylindrical, as this represents the *amount* of astigmatism. The correction might be

Sph. +2.75 ○ cyl. —4.50

or

Sph. —1.75 ○ cyl. +4.50.

the axes being placed respectively in the V and H meridians.

In the first correction the Sph. +2.75 fully corrects the hyper. in this meridian but it adds this amount of myopia to what already exists in the other meridian, hence the necessity for the – 4.50 cyl.

In the second correction the conditions are simply reversed.

Retinoscopic Results.

Except in very young children these should be corroborated or proved by subjective testing; that is to say, the acuteness of vision on letters should be ascertained by placing in the trial frame the refractive correction which has been ascertained, and any modification which clearly improves vision may be introduced.

A good plan to adopt in cases of astigmatism is to find the *cylinder* required—by the *difference* in the two meridians or, in cases of mixed astigmatism by the *sum* of the two amounts,—place this cylinder in the trial frame and add the best + or — spherical which gives the best result on letters.

CAUTION.—Whatever the retinoscopic result may be there can be no myopia if $V = \frac{6}{6}$

Practice in retinoscopy can be obtained with Mr. Percy Dunn's Model Eye, as every optical defect can be created, studied and corrected with the lenses of a trial case, with the great advantage of knowing whether your results are right or wrong. The observer's eye can thus be educated to appreciate at their proper value the various appearances and shadow movements.

SEE PAGE 83.

EXAMINATION of the FUNDUS

can be very easily made with

DAVIDSON'S

PATENT OPHTHALMOSCOPE.

CHAPTER XXII.

Points to be remembered in Testing and Prescribing Spectacles.

ALWAYS test the muscular condition after the refraction for both far and near.

Test each eye separately.

Always test the *distant* vision first.

All test types or lines pre-suppose a good light falling on them.

If the light should not be good, allowance must be made.

The operator should note, *at the distance at which he* is testing, the smallest letters or lines *he* can see and take *them* as his standard. If the operator's sight be *not* normal, he should, for this purpose, put on the lenses which correct his defect.

If it be found that nothing will enable the patient to see the letters or lines that he ought, the next size larger must be used, and if the same applies to these, use *larger still* as the standard, and so on, giving the strongest Convex or weakest Concave, as the case may be.

Where there is a great difference in the power of the lenses necessary for each eye it is not well to fully correct the more defective eye, as a certain amount of prismatic influence is caused by using two lenses which vary considerably in strength. A difference of, say, 3·50 D should be the limit of difference to begin with.

Advise the *constant* use of spectacles in Hypermetropia.

Advise the invariable use of glasses *for reading and all near work in Myopia;* the object being to compel the patient to read farther away.

"In astigmatic cases even if the patient cannot admit any *improvement* in vision by means of the proper glasses, the correction should still be used inasmuch as relief from asthenopia will be obtained." *Percy Dunn.*

Always exhaust the use of convex lenses first by finding if any improvement is apparent *in any meridian* before testing with concaves.

Concave lenses are used for correcting Myopia only; *every other defect* requiring convex.

The *strongest* lens is used *only* in Hypermetropia; every other defect must have the weakest.

The fact of a person seeing *as well or better at a distance with a convex lens* is a proof of hypermetropia, so in testing for astigmatism if he sees better in *any* Mn. with a convex, it proves Hyper. in that Mn.

In all cases of Astigmatism *except* Mixed, the *amount* is denoted by the *difference* in the power of the lenses necessary for each Mn. In Mixed Astigmatism it is the *sum* of the two.

*In speaking of the Meridians of **G.D.** and **L.D.*** the *Mns. of the* DIAL *are meant.*

In Myopic or Hypermetropic Astigmatism the Sph. lens required is that which corrects the Mn. of L.D., the Cyl. lens is the *difference* between the two, and the Axis of the Cyl. must always be in Mn. of G.D. (of the *dial).*

In cases where latent hypermetropia exists, which is usually shown by the patient seeing equally well with convex lenses of various strength, or esophoria being present, it is best to order glasses which correct the manifest Hyper, *to be worn constantly* for two or three weeks, and then make a second examination, unless retinoscopy has been done, when a fuller correction can be given.

The effect of the presence of the convex lenses in front of the eye will be to cause the muscles of accommodation to gradually relax, so that upon the second examination being made, a clearer result will generally be obtained.

The constant use of the glasses is imperative for this purpose.

In these cases, however, it is better for a retinoscopic examination to be made after the eyes have been atropised for a few days.

As a rule it is better to advise moderate use of the eyes than absolute rest. "Little and often" should be the order.

In fitting spectacles it should never be lost sight of that the eye is capable of neutralizing a considerable amount of refractive error.

It is unwise therefore as a rule to prescribe them for *slight* irregularities, as the result might easily be *less* comfort *with* the correction than *without*. It is not always the case that what is scientifically accurate is the most comfortable. If a patient *complains* of eye troubles, then even the correction of a slight refractive error may be attempted.

Even $\frac{1}{4}$ diopter of astigmatism *especially if oblique* will often cause headache.

The head of the patient should be kept erect and in a natural position, not canted to one side or downward, while the tests are being made.

Unsymmetric and oblique axes of astigmatism frequently make the patient habitually incline the head to either side or downward, so that when the errors are corrected in an abnormal position the result afterwards may not be satisfactory.

Cases of low-degree myopic astigmatism are too frequently not diagnosed in young people, and owing to the utter inability of the ciliary mechanism to neutralize them, they may produce severe reflex disturbances.

Ease of securing acuteness of vision by piling up the myopic sphericals leads to the error of ignoring the existing astigmatism.

Retinoscopy after a course of atropine in these cases is absolutely necessary.

"Full correction" of myopia is a prolific source of eye-strain.

Those requiring different glasses for distance and reading may have them of double focus.

The upper part is for distance and lower for reading.

Glasses must be carefully adapted to the occupation of the patient.

Artists, musicians, some music teachers, draughtsmen, barbers, machinists, some physicians and patients pursuing many peculiar occupations, require lenses with different foci from those of patients in other callings, and may even need exceptional styles and shapes of manufacture.

Glasses for constant use should be worn as close to the eyes as the lashes permit, the centre of the lenses coinciding with the centre of the pupils.

Glasses for reading may be worn a trifle lower and the eyes may be a shade closer together.

Spectacles and eye-glass frames are in every case required to hold lenses before the eyes in a position to render them aids to vision, and the first important consideration is that the eyes look through the centres of the lenses. Ill-fitting frames must always be a source of discomfort. If we put before the eyes lenses, each of which is out of centre, we shall give each an image which is more or less displaced, and the two eyes in order to fuse these two displaced images into that of a single object, must squint in a degree equal to the displacement. The effect of this is to disturb the natural harmony between the movements of the two eyes, and to fatigue and distress the muscles by which this unnatural position is maintained.

Ill-adjusted glasses are a frequent cause of eye-strain.

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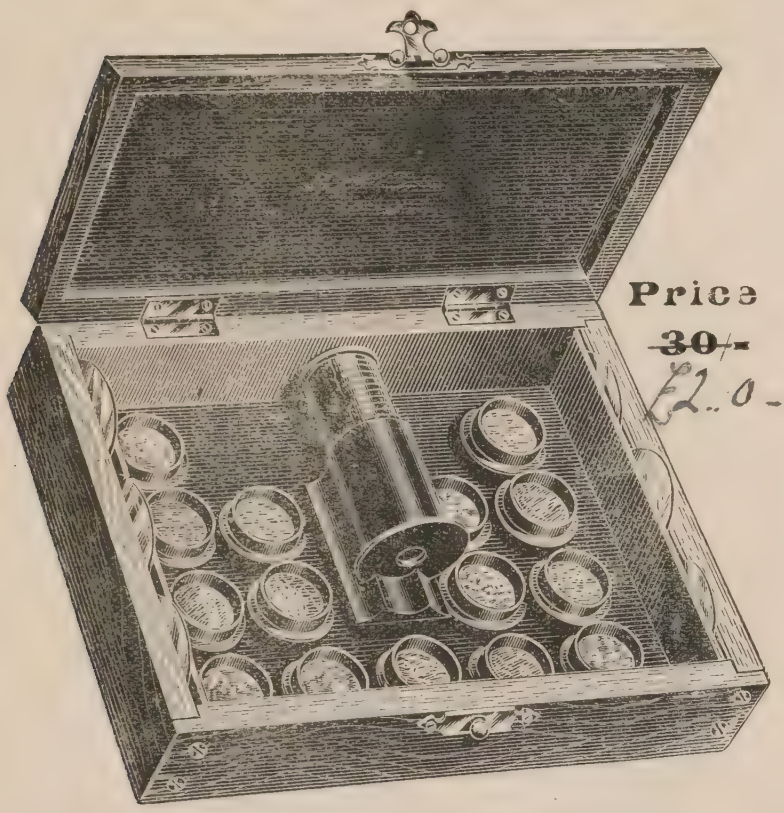

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